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PREFACE

The Geographical Branch was set up as a Bureau of the former Department of Mines and Resources in June 1947.

Its principal duties are to obtain, collate, and organize all the material relating to the geography of Canada that may be of use to the economic, commercial, and social life of this country; to prepare studies on specific aspects of the geography of Canada for the use of those engaged in government,. defence, business, scientific research, etc.; and to obtain material relating to the basic geographic facts and conditions of foreign countries, to the satisfaction of national or institutional interests.

Activities undertaken by the Branch are of two kinds—field studies in various parts of Canada, and the compilation of geographical material of both national and international significance. Reports issued are illustrated by maps and diagrams, and work in methods of mapping geographical data is undertaken. In addition, bibliographical and map reference services are offered to branches of Government, educational institutions, and the public. The field program of the Geographical Branch has been concerned mainly with sub-arctic and arctic Canada; that is, with those areas that are still too little known. It also includes surveys of the regional geography of the settled parts of Canada.

One of the main projects of the Branch during the next few years will be to assemble and correlate information from various departments of the Federal and Provincial Governments in producing a new national Atlas of Canada. When the Atlas is published, it should reveal as nothing else may the growing extent of the resources of the country.

The results of the field work and compilations of geographical material made by the Geographical Branch will be published, from time to time, in various memoirs. There will also be publications in the form of bulletins to describe work in progress. In this bulletin the studies of members of the Geographical Branch, or of geographers attached to the Branch, or commissioned by it to do special studies appear.

In so far as possible the bulletins will include each phase of the activity of the Branch. Articles on some aspects of the geography of Canada as a whole, together with articles on arctic Canada, on the sub-arctic, and on special areas in settled Canada will give some indication of the scope of the work and interests of the Branch. It is hoped that book notes of government reports, and abstracts of articles appearing in government journals, which have a bearing on the geography of Canada, will also prove useful.

J. WREFORD WATSON,
Director, Geographical Branch

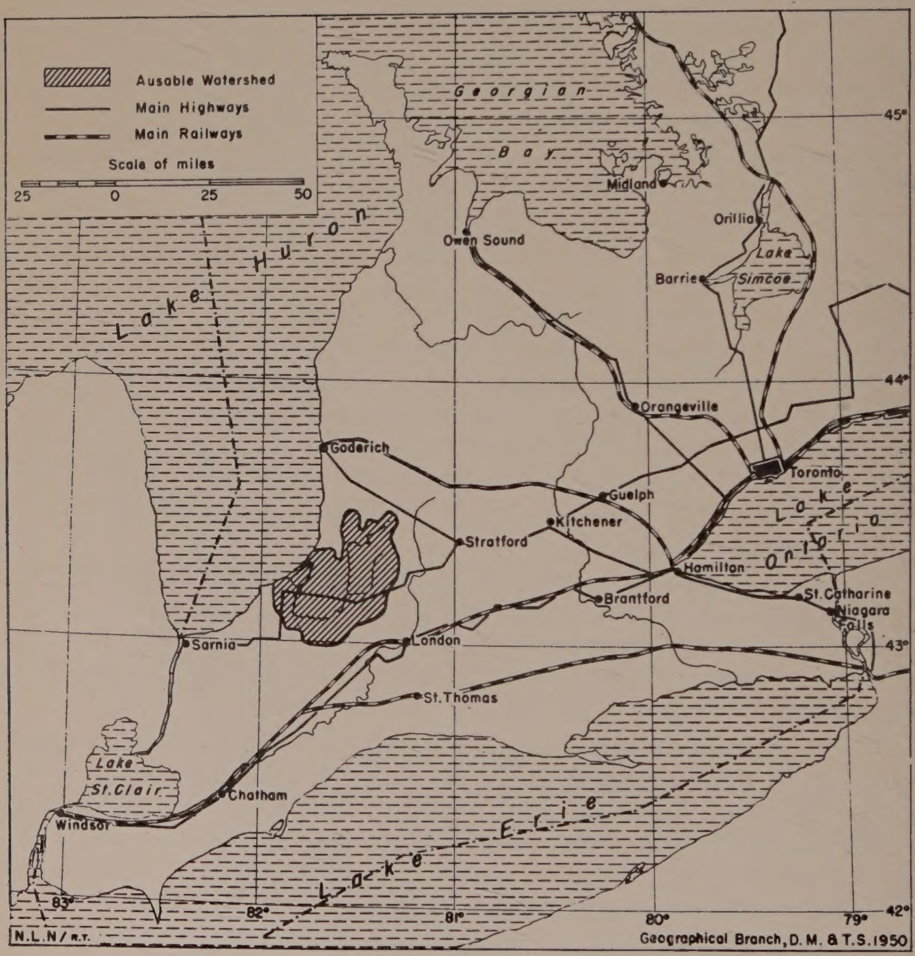

Figure 1. Location of the Ausable watershed.

THE ESTABLISHMENT OF SETTLEMENT PATTERNS IN THE AUSABLE WATERSHED, ONTARIO

Norman L. Nicholson[1]

One hundred and thirty years ago the Ausable watershed was a little known part of southwestern Ontario and most of it was covered with forest. The low-lying parts were densely forested and often swamp-like in character, whereas on the higher land there were stretches of park land and open forest. Ausable River flowed across this region following an extraordinarily sinuous course, especially near its mouth where it almost completely girdled a series of shallow lakes. Today, little more than one-tenth of the watershed is wooded and it has become an area of prosperous farms and vacation lands. Even the course of the river has been changed by the cutting of canals at Grand Bend and Port Franks, and by the straightening of many of its tributaries in order to accelerate the water runoff in spring.

The development of a region depends on accessibility and the Ausable region illustrates this maxim very well. Its development can be traced in several stages following changes in the mode of transportation, from the early days of the Indians and missionary-explorers, who travelled on foot or by canoe, to the present day with its emphasis upon automobiles and aircraft.

THE PERIOD OF HUNTING AND EXPLORATION

Early utilization of the Ausable watershed was made by the Attawandaron or Neutral Indians. While they were in possession of central and southwestern Ontario their economy was based on flint found near the present Stoney Point. The Attawandarons did little hunting, but devoted their time to the making of flint artifacts for trade with other Indians. The capital of the Attawandarons was outside the watershed near the site of present-day London. They had a trail from this point to Lake Huron, and it is also possible that they used the river itself. Hence, the first routes in the watershed were routes of commerce.[2]

Some parts of the area were almost certainly known to the early missionary-explorers, to such men as Daillon, Brébeuf, Chaumonot, Gelinée, and Dollier de Casson.[3]

Although the people of this period have left their imprint on the land, they did not influence the permanent pattern of the settlement. No permanent settlement took place until the early nineteenth century when roads began to spread into the region from the southeast.

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[1] Norman L. Nicholson, B.A., M.Sc., University of Western Ontario. Supervisor of Research on Canadian Geography, Geographical Branch, Department of Mines and Technical Surveys, Ottawa.

[2] Jury, W.: Early Indian History of the London district; Univ. Western Ontario, London, 1946, p. 2.

[3] Fox, W. Sherwood: T'aint runnin' no more; Wendell Holmes Ltd., London, 1946, p. 11.

Figure 2. The Ausable watershed—relief.

THE PERIOD OF SETTLEMENT ROADS (1820-1840)

The earliest roads in the vicinity of the watershed served the already settled area to the southeast. The survey of London township was completed at the close of the War of 1812, and that part of the township included in the watershed was settled in 1821 by a number of families who emigrated from South Wales to form what was probably the only Welsh settlement in Upper Canada, along Nairn Creek. Scottish settlement began in 1825 in the northern part of Lobo township.[1]

[1] Campbell, O. J.: The Settlers of Lobo Township; Trans. London and Middlesex Hist. Soc., vol. 8, 1917, p. 38.

Figure 3. Aerial photograph of the region about the northerly mouth of Ausable River. (Reproduced by permission of the Ontario Department of Lands and Forests.) The mouth was created by the cutting of a canal from the bend of the river at Grand Bend to Lake Huron in 1888. This and the earlier canal to Port Franks virtually divided the watershed into two parts. Ptsebe River (Parkhill Creek) provides the main contribution to the waters reaching Lake Huron at Grand Bend. The waters of the main Ausable and "The Old River Bed", part of which is clearly visible above, reach the lake at Port Franks. The village of Grand Bend is now an increasingly popular summer resort for Canadians and Americans alike. →

When the townships of London and Lobo were taken up, colonization roads became necessary to facilitate both settlement and new surveys. First, the "Egremont Road", forerunner of the present London-Adelaide-Sarnia road (Ontario Highway No. 22) was constructed, and Warwick-Bosanquet laid off into townships. The "London Road" (Ontario Highway No. 4) was built by the Canada Company, which had acquired from the Crown for subsequent re-sale all of the land in the watershed north and west of Lobo, London, Adelaide, and Warwick townships. This road was intended to connect Goderich and London and to open that part of the "Huron Tract" for occupation.

Figure 4. The Ausable watershed, 1829. The land taken up includes all land granted or sold, and Figures 4, 5, 6, and 7 are based on a map prepared by the Ontario Department of Planning and Development, with their permission.

Settlement gradually extended north and west along these roads. By 1831 most of what is now East Williams township had been settled by Scottish families; the colony at Wilberforce near the present village of

Lucan had been established for fugitive negro slaves[1], and its population boosted by the Irish emigration of 1835; settlers had taken up the land between the present villages of Centralia and Exeter; and hundreds of families were settled in the townships of Adelaide and Warwick. Adelaide village was established in 1832, and with the building of a church and a school became the nucleus of the first real settlement in the watershed. One settlement was made when a sawmill was established near what is now Grand Bend, but it remained isolated from the rest of the watershed for many years because it was accessible only by water and communication with Goderich and Sarnia maintained by way of Lake Huron.

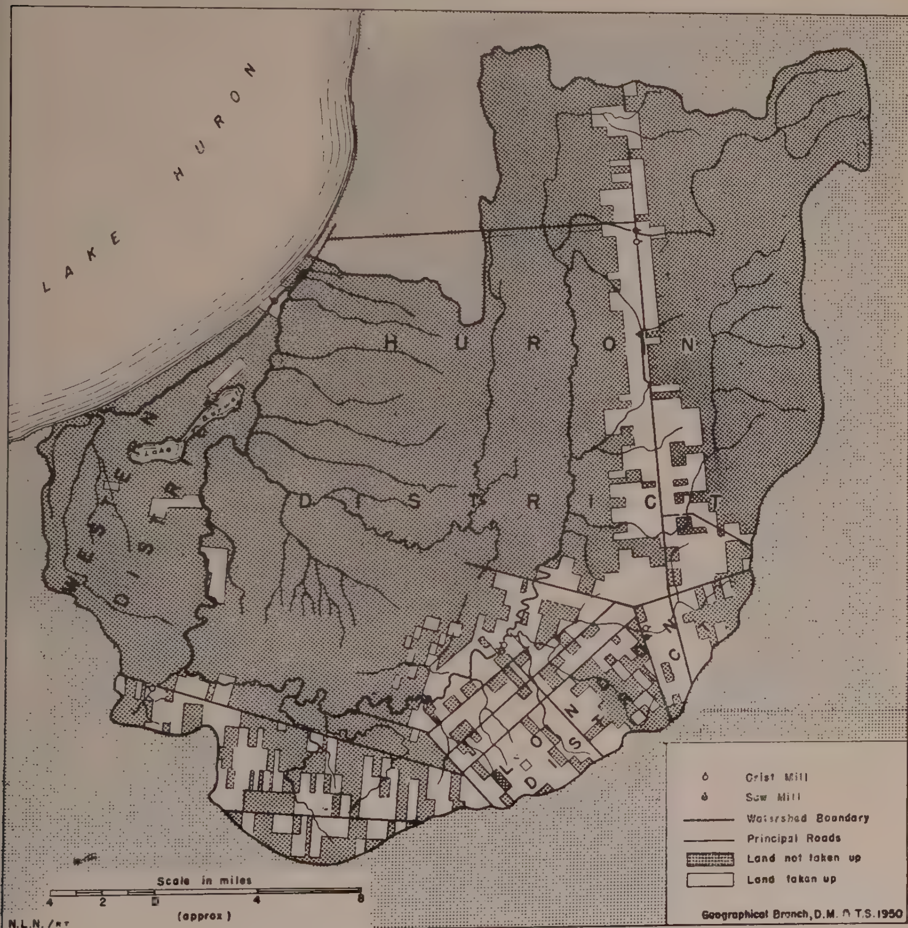

Figure 5. The Ausable watershed, 1839.

The accompanying maps illustrate how the two main human axes of the area were established during this period as settlement expanded over the higher land. The "Huron Road" was particularly noteworthy in this respect as it followed what has since come to be known as the Seaforth moraine[2].

[1] Landon, F.: The History of the Wilberforce Refugee Colony in Middlesex County; Trans. London and Middlesex Hist. Soc., vol. 9, 1918, p. 33.
[2] Chapman, L. J., and Putnam, D. F.: The Physiography of Southwestern Ontario; Sci. Agr., vol. 24, 1943, pp. 101-125.

THE SPREAD WESTWARD (1840-1860)

During the late 1830s and early 1840s the amount of land taken up in the watershed did not increase notably. Fewer settlers came to the area and those already established were occupied with clearing the land they had taken up and organizing their farms. Indeed, it was a widely held belief during those years that all the good and easily accessible land had been taken up, and as a result the lower westerly parts of the region remained

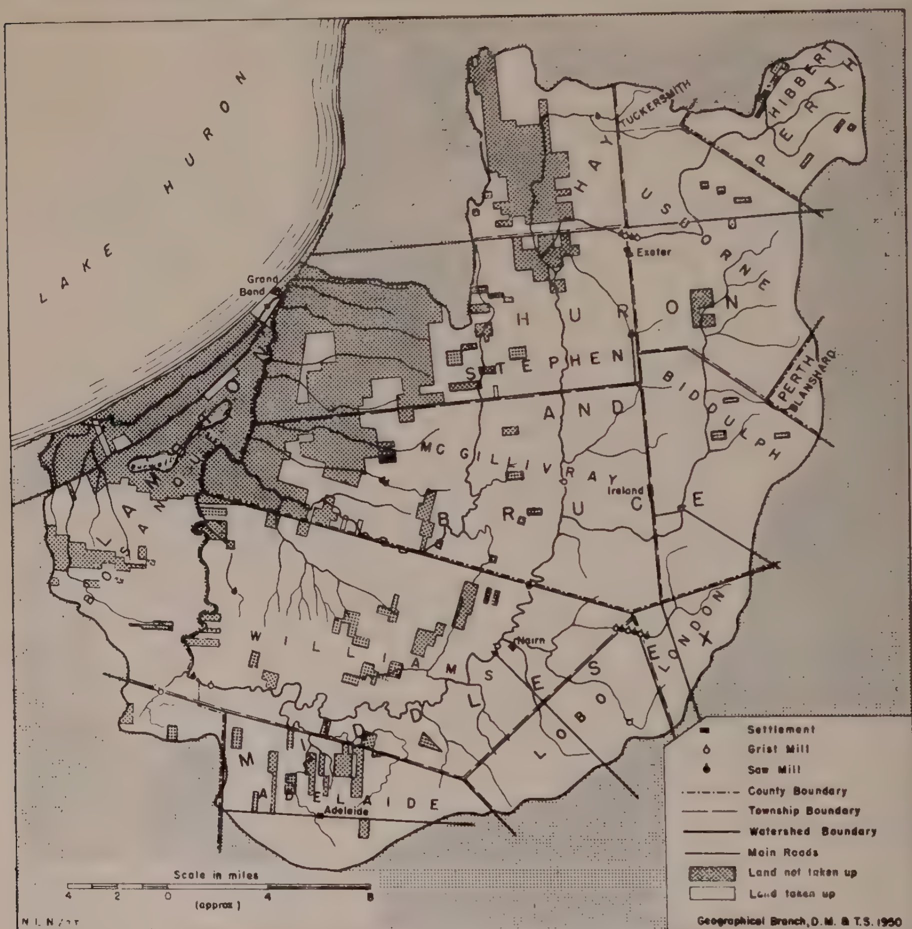

Figure 6. The Ausable watershed, 1854. By 1854, the only land not taken up was in the poorly drained areas. Municipal organization had occurred and the river was playing an important rôle in the lives of the people through its use for saw mills and grist mills.

virtually unoccupied. It was as though the people were on the edge of a vast amphitheatre looking down over the less well-drained land of which they had been made apprehensive, to say the least, by the warnings published in the various immigrants' guides *(sic)* of the period and by the experiences of "incautious settlers"[1]. Furthermore, these areas were more difficult to clear because they supported a denser forest cover.

[1] Smith, W. H.: Canadian Gazetteer, H. and W. Rosewell, Toronto, 1846, p. 215.

However, the increased migration of the late 1840s, due to depressed conditions in the British Isles, forced the spread of settlement into the interior of the watershed, although with reluctance. This increase in total population not only resulted in the building of more roads, but led to the development of village life. The first of these villages formed around the mills, especially the grist mill. As these were something of a luxury in the early stages of pioneer life in view of their cost, they often served a large area and became its nucleus.[1] Some villages were named after the mill owner, as was the case with Duncrief. Village growth was especially hastened if a variety of services were provided for the increasing numbers of people. For example, it was not until a tannery and a store were started at Exeter in 1847 that the settlement ever showed signs of becoming a village. Then as the older settlers acquired horses and buggies, blacksmiths became a necessity and they, naturally enough, were established at crossroads where four farms met. As stores and taverns took their place alongside them, the hamlet acquired a name, often that of the most prominent of the four farmers, such as Rodgerville and Corbett, or the owners of the taverns such as Whalens Corners and Flannigans Corners (later Ireland).

By 1860 most of the land had been taken up apart from the areas of true swamp, which were chiefly in the townships of Hay, Usborne, and Bosanquet and are now known as the Hay Swamp, Quintons Bog, and the Thedford Marsh. The first two of these are outstanding examples of conditions existing in the poorly drained inter-morainic crescents, and they further illustrate the relationship between the settlement pattern and the physical make-up of the watershed.

These developments also demanded some readjustments in local political organization. Williams township with its increased population proved too unwieldy a unit for administrative purposes and was divided into East Williams and West Williams. The inhabitants in McGillivray and Biddulph found it was easier for them to travel to London than to their own county town of Goderich and, consequently, their petition to become part of Middlesex county rather than remain part of Huron county was granted.

THE RAILWAY ERA (1860-1880)

In 1859, the Grand Trunk railway from Guelph to Sarnia was opened and in 1876 the London, Huron and Bruce railway was opened. The latter followed a line of settlement that had already been established because it followed closely that part of the London-Goderich road within the watershed. Thus it tended to strengthen the already existing pattern although it led to some concentration in the larger settlements along its route.

The Grand Trunk railway, on the other hand, crossed a thinly populated region that had not long been developed. As the railway proved a greater attraction to settlers than the road, there was a new trend in the distribution of population. The effect was to lessen the importance of the

[1] Jury, W.: The Grist Mill; Univ. Western Ontario, London, 1946.

southern road route through Adelaide lying between the railways to the south of the watershed and the Grand Trunk railway to the north. The attraction of the railway is well illustrated by Thedford, which before 1859 did not exist, but when a station was located there to serve the existing village of Widder it gradually became the nucleus of a new town and began to absorb the life and vitality of Widder and grow at its expense until the latter ceased to exist.[1]

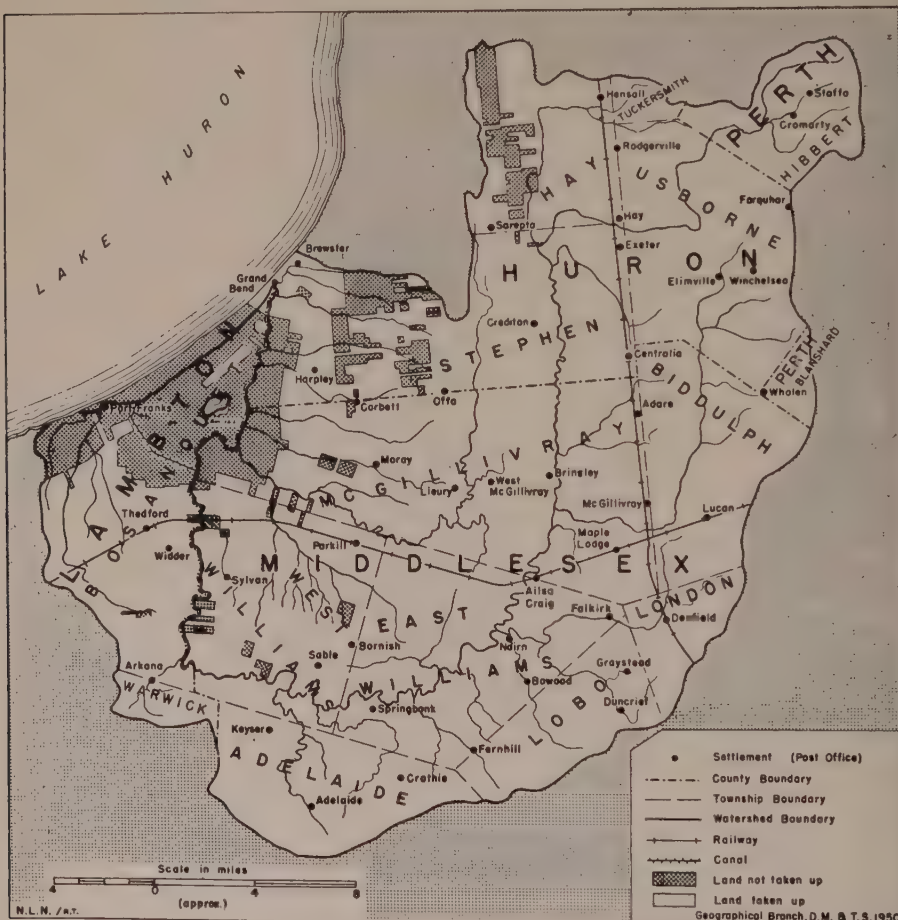

Figure 7. The Ausable watershed, 1876. By 1876 artificial drainage, notably the canal to Port Franks, had increased the amount of land available for agriculture, and administrative boundaries had been rearranged to the pattern that exists today.

The railway proved to be as great an incentive to immigration as the settlement roads had been in the earlier days. As the rural district filled up, so the older villages grew and new villages became established depending upon the ease with which the village could communicate with other centres. In those parts of the watershed that still bore an extensive forest

[1] Historical Atlas of Canada, Lambton County ed., H. Belden and Co., Toronto, 1879.

cover the railways also made it possible to send more and more timber to distant cities cheaply and quickly. Clearing the lower land, especially in the Williams townships, where it had formerly been difficult now became profitable. Hence, additional people were employed exploiting the forest resources as rapidly as they could. Parkhill and Ailsa Craig became centres for stave gangs and the exporting points for raw timber.

The canal, cut in 1875 across Bosanquet township to Lake Huron near Port Franks, drained part of Lake Burwell and this increased the possibility of further settlement, as did the similar but smaller scale utilization of other mucklands in the watershed.

This period saw the maximum density of population and the maximum exploitation of the natural resources of the Ausable region so far as the techniques of the time permitted.

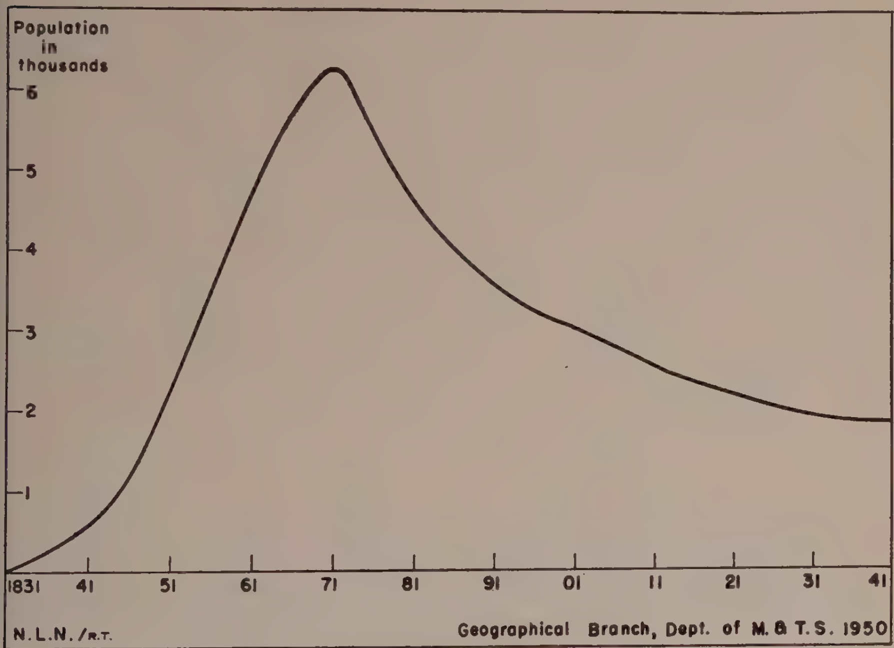

Figure 8. The changes in population in the townships of East and West Williams, 1833-1941.

THE PERIOD OF READJUSTMENT (1880-1915)

From 1871 to 1881 there was undoubtedly less increase of population in the Ausable watershed, and by 1891 a general decrease of population had set in.

It is questionable whether this should be considered a true decline, because when the timber was gone a startling change in land use occurred. The loss of population should rather be considered as a readjustment, for when the farm income could no longer be supplemented by a notable

income from forest products, and when it was no longer possible to obtain a living exclusively from lumbering, the watershed inevitably could not support as many people. Although the suddenness of the decline was accentuated by other factors, notably the opening of Western Canada, and urban growth with the machine age, the decline was greatest in those areas that could not turn to diversified farming. The Williams townships had become the centre for stock raising as well as the core of the area in which lumbering thrived. With the decline in lumbering, many villages in these townships became cattle raising and cattle exporting centres, and unable to establish new activities based on animal farming they were not able to employ large numbers of people. No other townships lost population to the same extent as these two townships and no villages lost people as markedly as Ailsa Craig, Nairn, and Falkirk. Towns like Exeter in mixed farming areas survived much better after the timber was gone, especially as they had established a variety of special services, such as tanneries and stores, in the period before the impact of the factors that necessitated the readjustment.

Nevertheless, the fact that the whole of the watershed lost some people was undoubtedly due also to the advance in mechanical transport and the transformation of roads into highways. As a result of such legislation as the Highway Improvement Act of 1901 and the Ontario Highway Act of 1915[1], the road as a transportation route came into prominence again although with a changed rôle. Just as it had once brought people into the region, so it now aided the railway as a means for their removal. In fact, highways were often built in such a way that they strengthened the railway pattern. However, where highways served settlements such as Exeter, which had not declined during the railway era, the rate of depopulation was less than in the case of those settlements that had declined during the railway era. Adelaide village, already mentioned as an example in this connection, almost disappeared as a result of improvements to the London-Sarnia road.

Thus, just as settlement had once spread from the southeast, so the southeast drew people back from the Ausable watershed. It was as though a giant wave had swamped the area only to withdraw and leave a dispersed rural settlement pattern.

TRENDS SINCE 1915

Today, farmsteads are scattered evenly over the countryside, and in some cases it would be difficult to discover the village centre except for the road sign, the gas station, or the village church. Several larger settlements like Hensall, Exeter, Parkhill, Arkona, and Thedford have become market towns. Outside of these centres the more densely populated areas occur where there is mixed farming with emphasis on crop raising, and in the areas of market gardening and fruit growing.

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[1] Miller, J. D.: Milestones of Ontario Highway Improvements; Ontario Department of Highways, Toronto, c. 1946.

There are already signs that the aeroplane is now producing changes in the population distribution in the watershed, and its unique facilities for rapid transportation are leading to remarkable seasonal patterns. The establishment of airfields at Centralia and Grand Bend has tended to bring new vitality to the watershed through the additional personnel employed

Figure 9. The transportation facilities of the Ausable watershed, 1950.

and the personal services they require. This is especially true of Exeter, although some of the men who work at Centralia have established residences as far away as Grand Bend. The airfield at Grand Bend allows vacationists to reach this popular resort, and in addition serves as a nucleus for flying clubs.

The Ausable watershed has unique attractions for the holiday maker. Apart from the strip of shore along Lake Huron, there are scenic localities such as the gorge that Ausable River has cut through the Wyoming moraine

Figures 10 and 11. The villages of Thedford (above) and Hensall (below), looking west. These villages illustrate the control of the railways and highways in establishing the morphological pattern of agglomerated settlements in the Ausable watershed. As both were established during the railway era their business centres include the railway station. In contrast, the business centres of settlements established before the railway era, like Exeter, are on the main highway, the railway station being on the edge of the settlement. *(Reproduced by permission of the London Free Press.)*

near Arkona, for long a fossil hunting ground for geologists. Located as the watershed is in relation to large centres of population such as London, Sarnia, and Detroit, improvement in the means of transportation could accelerate the further utilization of its resources and link to a greater degree the physical geography with the human, both past and present.

RÉSUMÉ

On peut retracer les étapes du peuplement dans le bassin de drainage de la rivière Ausable, depuis les premiers occupants, les Indiens Attawandaron, jusqu'à aujourd'hui. Les pionniers s'établirent dans la région au début du 19e siècle; ils suivirent d'abord les premiers arpenteurs et pénétrèrent ensuite dans tout le bassin grâce aux nouvelles routes construites le long des hautes terres. Vers le milieu du siècle, des immigrants vinrent augmenter la population qui commença à se grouper en villages. Aux environs de 1860, presque toutes les terres, excepté les zones marécageuses, avaient été occupées. La construction des chemins de fer entre 1860 et 1880 et l'augmentation des moyens de transports changea la structure des établissements fondés sur les routes et sentiers et, favorisa une utilisation des ressources naturelles du bassin, en particulier l'exploitation des forêts. Vers la fin du siècle dernier, cependant, la population rurale déclina dû au gaspillage des réserves forestières, à l'ouverture de l'Ouest canadien, à la colonisation et à la croissance des villes situées à l'extérieur du bassin. La transformation des chemins ruraux et sentiers en voies de première classe (*Highway Improvement Act* 1901) provoqua davantage l'exode de la population et dispersa à nouveau les établissements ruraux, éparpillant les fermes ici et là dans la campagne. On vit apparaître des petits centres commerciaux au détriment de beaucoup de villages qui disparurent à peu près complètement. La construction de champs d'atterrissage et une affluence croissante de villégiateurs a augmenté récemment la population du bassin.

THE PHYSIOGRAPHY OF THE MIDDLE AND LOWER THELON BASIN

John B. Bird[1]

The western shore of Hudson Bay was one of the first areas of northern Canada to be visited by Europeans. The investigation of the interior of the District of Keewatin was begun by Hearne between 1770 and 1772 and continued by Back in 1834. It was not, however, until 1893 that the modern era of exploration began. In that year J. B. Tyrrell travelled down Dubawnt River from its headwaters to Thelon River and thence to Hudson Bay. The following year he made a similar voyage down the Kazan. The explorations of J. W. Tyrrell, Hanbury, and many other men have increased our knowledge of the area, but their work has two main drawbacks for the student of physiography. In the first place, the routes followed in summer were invariably along the major rivers. In winter, climatic conditions were unfavourable for any detailed examination of the landscape. In the second place, physiographers were rarely included in the parties, and even when they were they had time only for reconnaissance surveys. Thus, despite the relative accessibility of the region west of Hudson Bay there are still large areas, particularly north of Thelon River, that have never been visited by scientists and that until last year had not even been seen from the air. Up to the present no general physiography, let alone detailed physiography, has been written.

GENERAL PHYSIOGRAPHY

Virtually all the scientific observers who have visited Keewatin have been influenced by the vast monotony of the region with its ill-defined river systems, low relief, and multitude of lakes. For this reason few attempts have been made to divide it into smaller regions for a rational description of the landscape, although the area was from the earliest investigations placed in the major physiographic province of the Canadian Shield.

The only subdivision that has been generally followed is that between the Interior Upland and the Coastal Plain. J. B. Tyrrell[2] was the first to make this distinction. He describes the Interior Upland as having a mean elevation of 900 to 1,000 feet and generally a sandy till surface. The Coastal Plain lies below the upper limit of the post-glacial marine submergence, which he places at between 500 and 600 feet. Raised beaches and cliffs mark the former level of the sea. Although he states that the two regions are distinct some later writers[3,4] are of the opinion that the

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[1] John B. Bird, M.A., Cambridge University, Asst. Prof., Dept. of Geog., McGill Univ. Leader of party in Geographical Bureau Expedition into Keewatin, Northwest Territories, 1948.

[2] Tyrrell, J. B.: Report on the Dubawnt, Kazan and Ferguson Rivers; Geol. Surv., Canada, Ann. Rept., vol. IX, 1898, pt. F, p. 159.

[3] Alcock, F. J.: Geology and Physiography. *In:* Canada's Western Northland; Canada, Dept. of Mines and Resources, Parks and Forests Branch, Ottawa, 1937.

[4] Macdonald, C. S.: Geography. *In:* Canada's Western Northland; Canada, Dept. of Mines and Resources, Parks and Forests Branch, Ottawa, 1937.

division between the two regions is more difficult to make. Cooke[1] on the other hand goes further than Tyrrell and places the Interior Upland in the Canadian Shield physiographic province, and the Coastal Plain is made part of the Hudson Bay Lowland.

Southwest of Hudson Bay this lowland is a valid physiographic region that has developed on Palæozoic sedimentary rocks. North of Churchill rocks of this age are replaced by Precambrian rocks, and although the landscape is superficially similar in detail the change is considerable.

Figure 1. Eastern Mackenzie, central and southern Keewatin, Northwest Territories, showing the location of the area surveyed.

If Tyrrell's definition of the Coastal Plain as the area that has been submerged in the post-glacial period is accepted, its boundary may be drawn with some certainty. The glacial and post-glacial evolution of the area has, however, been more complex than was at first realized. In the Thelon and lower Kazan River basins the upper limit of marine action is between 325 and 400 feet. Above this height, in the west of the area, raised lacustrine beaches and cliffs are found to at least 750 feet. As the boundaries of the glacial lakes are unknown, it is impossible at present to delimit the areas that have been submerged in Keewatin. The influence

[1] Cooke, H. C.: Glacial Depression and Post-glacial Uplift. *In:* Studies of the physiography of the Canadian Shield; Trans., Roy. Soc., Canada, vol. 24 (2), sec. 4, pp. 52-53 (1930).

of the submergence on the landscape has indeed been over-emphasized. The period of stationary water level in the lakes and in the sea was so short that cliffs were only formed in weak sedimentary rocks and fluvioglacial sands. Even in the sandy till plains the submergence has only re-sorted the upper layers of the till and has not radically modified the landscape.

The physiographic differences between the Interior Upland and the Coastal Plain are not, therefore, very distinct, and it may be doubted whether the division is of sufficient importance, using the original criteria, to warrant its adoption in Central Keewatin.

There is another approach to the problem of the subdivision of the Keewatin area that has not yet been developed. In other parts of the Canadian Shield the peneplain has been shown to be complex, with more than one erosion surface.[1] In Central Keewatin there is evidence of two erosion cycles. The surface formed by the first erosion cycle is higher than the second and has been dissected by it in the east, although in the west it becomes continuous. A detailed discussion of the relationship between the two surfaces and of the general physiography is not possible until more data are available. These data will most easily be obtained by field studies over small areas, supplemented by the detailed inspection of the air photographs that now exist for all Keewatin. Such a field study was made in the summer of 1948 when the Geographical Bureau sent a party into the middle and lower Thelon Basins. The party of four, with an Eskimo guide, left the settlement at the west end of Baker Lake early in July. They travelled by canoe up the fast-flowing Thelon River to the three large lakes through which the river flows in the middle of its course. The party remained in the area for 2 months and made frequent journeys on foot for distances up to 20 miles from the river.

The Thelon area is of more than average interest in elucidating the physiography in the region west of Hudson Bay. Thelon River and its main tributary, Hanbury River, rise in lakes close to Artillery Lake 1,200 feet above sea-level, and flow in an easterly direction for over 550 miles to Baker Lake. If Baker Lake and Chesterfield Inlet, the lower drowned parts of the Thelon, are included, the length of the river from the source to the sea is 700 miles. On the floor of Hudson Bay the extension of the Thelon Valley may be traced by submarine contours to Hudson Strait and was probably formed prior to the submergence of Hudson Bay. The age of the river is unknown, but it certainly pre-dates the last glaciation. The Thelon gorge between Schultz and Baker Lakes is filled with till and is, therefore, older than the last ice advance. The gorge is in turn pre-dated by a mature river valley, now only occupied by lakes and misfit streams, which leads out of the southeast corner of Schultz Lake to Baker Lake.

In addition to being old by comparison with many of the rivers of the Canadian Shield, the Thelon Valley forms a boundary between the drainage pattern and landforms to the south and those to the north. On the

[1] Tanner, V.: Newfoundland-Labrador, vol. 1, Cambridge, 1947, p. 166.

ure 2. The lower Thelon at Half Way Hills showing the pre-glacial gorge, and the depth of till on the farther side. The river is 600 yards wide at this point.

Figure 3. The Mallery Lake lowlands from the Marjorie Hills.

south side of Hanbury-Thelon River, the peneplain rises to the south from near sea-level to 1,700 feet by Kasba Lake. Three major rivers, the upper Thelon, Dubawnt, and Kazan, are consequent on this regional slope. Superimposed on this slope in the southeastern part of Keewatin is a second slope towards Hudson Bay, down which flow shorter rivers, including Thelewiaza, Maguse, and Ferguson Rivers, directly to the sea. The age of the second slope is uncertain, but it may be much younger than the main northeast regional inclination.

Although some of the evidence is contradictory, it seems that the floor of Hudson Bay is still rising after the depression produced by the ice-cap during the glacial epoch. When the isostatic recovery is complete, Hudson Bay may no longer exist.[1,2] If this is the case then the regional slope of the floor of Hudson Bay will also be to the north and the second slope of the peneplain in Keewatin to the southeast will disappear (*See*, however, Wilson[3], who suggests there is evidence for a more permanent depression in Hudson Bay).

North of Thelon River the land rises to a watershed about 1,000 feet above sea-level separating the Thelon from Back River. The middle and upper reaches of Back River have striking similarities with the Thelon, but in its lower course Back River turns north and enters the Arctic Ocean. Although there are extensive sandy till lowlands in the Back River basin much of the country is very rugged and the relief is greater than in the area immediately south of the Thelon. A line that runs approximately along Thelon River is, therefore, seen to mark not only the boundary between two dissimilar drainage patterns in Keewatin but also between two different physiographic areas.

During the summer of 1948 it was apparent that the Thelon Basin from Hornby Point in the Thelon Game Sanctuary (the western limit of the investigation) to Baker Lake could be divided into a number of small physiographic units. Although the units have many features in common they are distinct and easily recognizable on the ground. An understanding of how the different units developed requires a knowledge of the geological structure, the pre-glacial physiography, the Pleistocene glaciation, and the weathering processes during the post-glacial period.

THE GEOLOGICAL STRUCTURE

With the exception of a small area in the north, nearly the whole of Keewatin and the eastern part of the District of Mackenzie are underlain by Precambrian rocks. Large areas remain to be examined, but the Precambrian rocks in Keewatin appear to fall into two groups. The earlier one is known as the Archæan and consisted formerly of sedimentary and

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[1] Cooke, H. C.: op. cit., p. 69.

[2] Gutenberg, B.: Changes in Sea-level, Post-glacial Uplift, and Mobility of the Earth's Interior; Bull., Geol. Soc. of Amer., vol. 52, pp. 747-751 (1941).

[3] Wilson, J. T.: Some Aspects of Geophysics in Canada with special reference to structural research in the Canadian Shield; Trans. Amer. Geophysical Union, vol. 29, p. 723 (1948).

volcanic rocks that have been intruded by granite and highly metamorphosed. In the Thelon Basin the Archæan rocks are less extensive than elsewhere in the Northwest Territories. Granite-gneiss of this age is found along the north shore of Schultz Lake from where it extends northwards for an unknown distance. The granite-gneiss is crossed by linears with a north-northwest by south-southeast alinement. Basalt dykes and a fault northwest of Schultz Lake show the same orientation. The lower Thelon gorge has been eroded in schists that are considered to belong to this earlier group.

The second group is the Proterozoic rocks, which are mainly of sedimentary origin. They occupy the whole of the area under discussion with the exception of the north shore of Schultz Lake and the Thelon gorge. The commonest sedimentary rock is a white, occasionally reddish, coarse-grained sandstone. It is thin bedded and frequently shows well-developed ripple-marks. Bands of conglomerate formed of quartzite pebbles are found in the sandstone, and in some areas there is considerable quartzitic sandstone. The strata are horizontal around Beverly and Aberdeen Lakes, but have been gently folded south of Schultz Lake. Although none of the sedimentary rocks is as resistant to erosion as the granite-gneiss, it is the variation within the sedimentary rocks that has produced the greatest relief in the area. The sandstones form the low-lying lake area whereas the quartzitic sandstone and conglomerate are found in the hills.

No rocks of later age than Precambrian are found in the Thelon Basin, but the physiographic development of the area can be traced approximately by reference to other parts of the Canadian Shield. A long period of erosion followed the Precambrian era, during which the Canadian Shield in the northwest was reduced to a peneplain. In the Ordovician era the area was submerged by the sea. Ordovician limestone is found in northeast Manitoba, Southampton Island, and at Nicholson Lake 25 miles southwest of Dubawnt Lake. The widespread occurrence of these deposits suggests that the Ordovician limestone may have covered the entire region. It is uncertain whether the land rose at the end of the Ordovician or the inundation continued into the Silurian.

Erosion was renewed towards the end of the Palæozoic and the capping of limestone rocks was removed. No deposits are known from the Silurian to the Pleistocene in Keewatin. The presence of Cretaceous rocks of estuarine origin at the south end of James Bay in Ontario, and of similar rocks probably also of Cretaceous age 35 miles southeast of Churchill in Manitoba suggests that the west side of Hudson Bay was close to sea-level during the late Mesozoic era.

The history of the region during the Tertiary period is unknown. A level erosion surface with residual monadnock hills is found today 400 feet above sea-level around Baker Lake. It rises slowly inland and is 700 feet above sea-level south of Aberdeen Lake. The presence of this surface suggests that in the recent geological past the region was uplifted, and

erosion, which must have been almost at a standstill on the peneplain, was renewed. Insufficient time has elapsed to destroy all traces of the old surface. North of Baker Lake it is still almost complete, and from it Prince and Quoitch Rivers fall into Baker Lake and Chesterfield Inlet by a series of rapids. In the middle Thelon Basin the older erosion surface has been much dissected. South of the river in the sandstone area it is found only on the summits of the hills, although on the granite-gneiss rocks north of the river it is more continuous.

THE PHYSIOGRAPHIC EFFECTS OF THE ICE AGE

In the Pleistocene epoch Keewatin was covered by ice-sheets. The complete history of the glaciation has yet to be unravelled, and although it is believed that the area was subject to the same multiple glaciation that other parts of the world experienced there is little definite proof of it. During the last glaciation the rock gorge of the lower Thelon was blocked with till, which the river has only partly removed. Southwest of the gorge and parallel with it the mature valley is blocked by morainic material. The origin of the gorge is, therefore, probably to be found in the diversion of the Thelon from the mature valley at the close of an earlier glaciation. The broad valley southeast of Aberdeen Lake suggests an even earlier course for the Thelon, but the evidence is inconclusive.

When J. B. Tyrrell made his journeys down Dubawnt-Thelon and Kazan Rivers he made observations of the orientation of the glacial striæ. As a result of this field work a Keewatin centre for the east North American ice-sheet during the Wisconsin glaciation was postulated, which was contemporaneous with the Labrador ice centre. The Keewatin centre in Tyrrell's theory was not stationary but shifted from the area between the Thelon and Pelly Lake on Back River to a point between Dubawnt and Yathkyed Lakes and then split into two. After the division the main centre was east of Yathkyed Lake and a minor centre north of Baker Lake. The presence of an ice centre west of Hudson Bay was accepted by most glaciologists, and as a result of further exploration subsidiary centres were suggested. Glacial striæ, which are the evidence for the Keewatin centres, are now known to be unreliable unless supported by other evidence. The absence of climatological and topographical arguments for a Keewatin centre and the evidence from other fields of research has led some glaciologists, notably R. F. Flint[1], to the conclusion that Keewatin was never the centre of a main ice-sheet and that during the maximum extension of the ice the thickest part lay over Hudson Bay.

All the evidence of ice movement in the Thelon Basin supports a Hudson Bay origin for the ice. Two ice lobes existed in the area during the latter part of the Ice Age. The first ice lobe moved from the east-southeast and covered the entire area. Large deposits of till were formed between Aberdeen Lake and Hornby Point on the upper Thelon at this

[1] Flint, R. F.: Growth of the North American Ice-sheet during the Wisconsin Age; Bull. Geol. Soc. Amer., vol. 54, pp. 325-362 (1943).

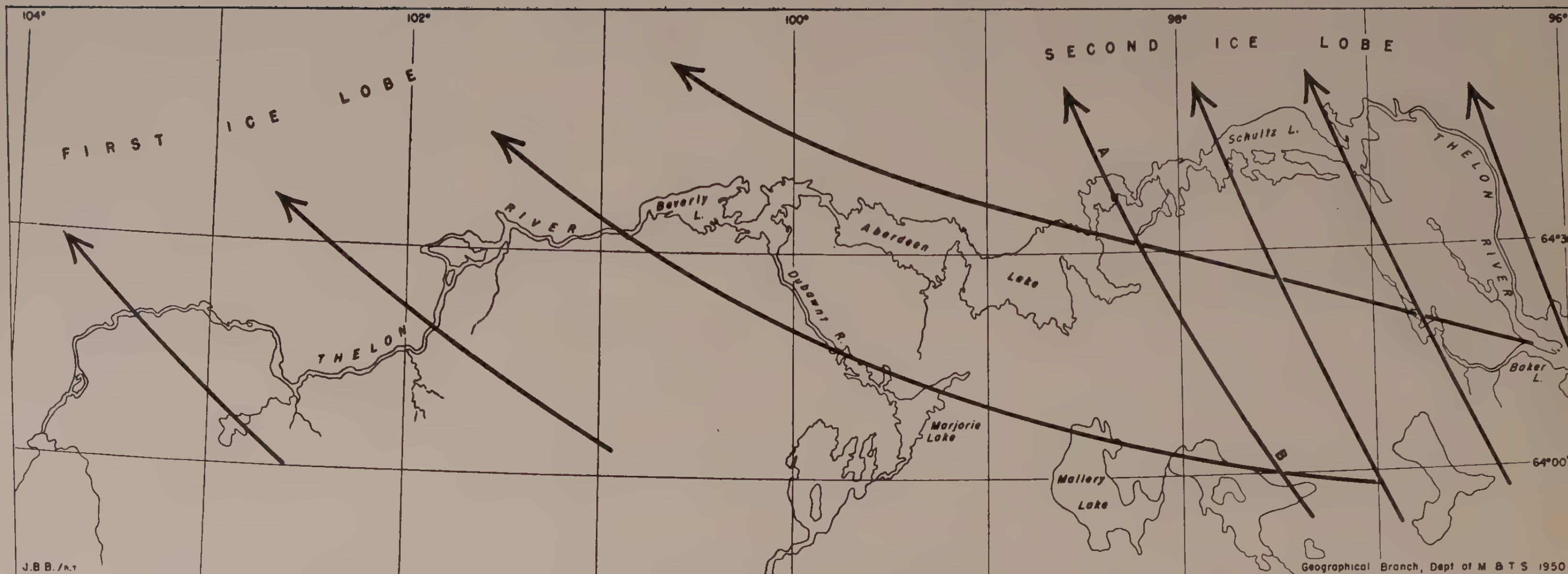

Figure 4. The direction of ice flow during the closing stages of the Ice Age. West of the arrow A-B the whole area was submerged at one stage by a glacial lake.

time. As the ice front of the first lobe retreated to the east the natural drainage from the uncovered land in the west was blocked by the ice and a glacial lake was formed. The highest level of the lake is unknown. A raised beach is found at 740 feet above sea-level south of Aberdeen Lake. During the earliest stage of the lake the surface may have exceeded 800 feet above sea-level. Englacial rivers deposited deltas in the lake at the ice front, and the larger deltas are conspicuous features in the present landscape.

When the first ice lobe had retreated to Schultz Lake its place was taken by a second lobe moving from the south-southeast. The second lobe failed to cover the whole of the Thelon Basin and its western front lay between Aberdeen and Schultz Lakes. The glacial lake remained dammed back by the second lobe, but as the ice waned lower outlets for the lake were uncovered and the lake level fell by stages. Finally the ice disappeared, but as the earth's crust remained depressed after the weight of the ice was removed Hudson Bay extended beyond its modern shore and invaded the lower lying areas. The upper level of the sea was approximately 360 feet above present sea-level in the middle Thelon Basin. Since then the land has risen continuously to the present day, a movement that is apparently still in operation.

The influence of the glaciation on the landscape was threefold. In the areas of more resistant rock, mainly the Archæan, but also the higher and harder elements of the Proterozoic rocks, the erosional forces were dominant. The landscape has been smoothed, but not sufficiently to destroy pre-glacial landforms, the rock surface has been polished and *roches moutonnées* have developed. In addition, differential erosion has over-deepened Baker and Schultz Lakes; the floors of both lakes are below sea-level and below the rock bars at their outlets. Many of the smaller lakes north of Schultz Lake lie in rock basins also formed by over-deepening. In the west of the area under discussion depositional forms are extensive. Till mantles the underlying rock, which appears only near the summits of the hills. The depth of till varies considerably, but reaches more than 135 feet near Tibielik River. The till has been furrowed by the ice into long, low, drumlinoid forms, which may be ½ mile to 5 miles long but rarely more than 200 yards wide or 20 feet high. Poorly developed furrows in the till are found around Aberdeen Lake, but west of Beverly Lake they became the dominant element in the landscape. Eskers and fluvioglacial deltas are found in the west of the area and are another depositional product of the ice.

The third type of modification to the landscape that owes its origin ultimately to the ice is that produced by the glacial lake and the post-glacial marine submergence. When the lake and marine waters washed over the sandy till they re-sorted an upper layer that varies from 5 to 20 feet in thickness. The submergence also emphasized the till furrows. It removed the finer material from the tops of the drumlinoids and deposited it in the 'lows', leaving gravel and small boulders on the upper surface. A more spectacular result of the submergence was the formation of raised beaches

and cliffs on the sides of hills. Above 360 feet, the approximate upper limit of the marine submergence, low cliffs and wave-cut platforms in rock are present, in addition to gravel and sand beach ridges. Below 360 feet the absence of a stable water level for any long period of time has precluded the formation of extensive cliffs and benches, but beach ridges are present in large numbers.

GEOMORPHIC WEATHERING PROCESS

Since the waning of the ice-cap and the retreat of Hudson Bay, the landscape in Keewatin has been further modified by the processes of weathering that operate in continental subarctic climates. A characteristic of subaerial denudation in polar regions is the dominance of mechanical over chemical weathering. Under polar conditions the most important agent of rock disintegration is generally freeze-thaw action. In the Thelon Basin mechanical weathering is not found on the same scale as in the Canadian Archipelago or Greenland. Talus only exists in quantity at the base of conglomerate bluffs on the north shore of Schultz Lake, where it reaches 40 feet in height. The disintegration of conglomerate and granite-gneiss on horizontal surfaces is slight. The sandstone rocks of the area are normally covered by till, and hence the rock surface lies below the active layer of the permafrost and is not subject to freeze-thaw action. South of Schultz Lake, where the till cover on the sandstone is very thin or absent, the upper layers of rock have disintegrated into plates that form a protective layer on the underlying rock.

Frost action also produces differential sorting of the regolith in areas with a polar climate. The resultant soil and stone structures are widely distributed in the Arctic. No true stone polygons were observed in the Thelon Basin. There are a few small areas with soil stripes, and local sorting may be seen in clay patches in the till areas that are covered with tundra vegetation. These patches are free from vegetation and up to 3 feet in diameter. On the other hand, 'Hillock Tundra'[1], which is thought to be the result of frost action, is found throughout the area, particularly on the till when the sand content is not too high. Solifluction is also slight and was seen only on an extensive scale on the north shore of Schultz Lake where the till is banked up against a granite-gneiss scarp. The till in this area contains only a low proportion of sand.

Nivation hollows are present in the Thelon Basin. Snow patches persist in sheltered situations throughout all but the hottest summers. The opportunity was taken in late August 1948 (one of the hottest summers ever recorded in the eastern Canadian Arctic) to examine the hollows when the snow had melted. Where the snow patches had persisted on rock, the erosion had been slight although the rock was more shattered than in surrounding areas. Snow patches on the till have formed hollows, but they are few in number and physiographically insignificant.

[1] Polunin, N.: Botany of the Canadian Eastern Arctic, Pt. III, Vegetation and Ecology; Canada, Dept of Mines and Resources, Nat. Mus. Bull. 104, p. 84, Ottawa, 1948.

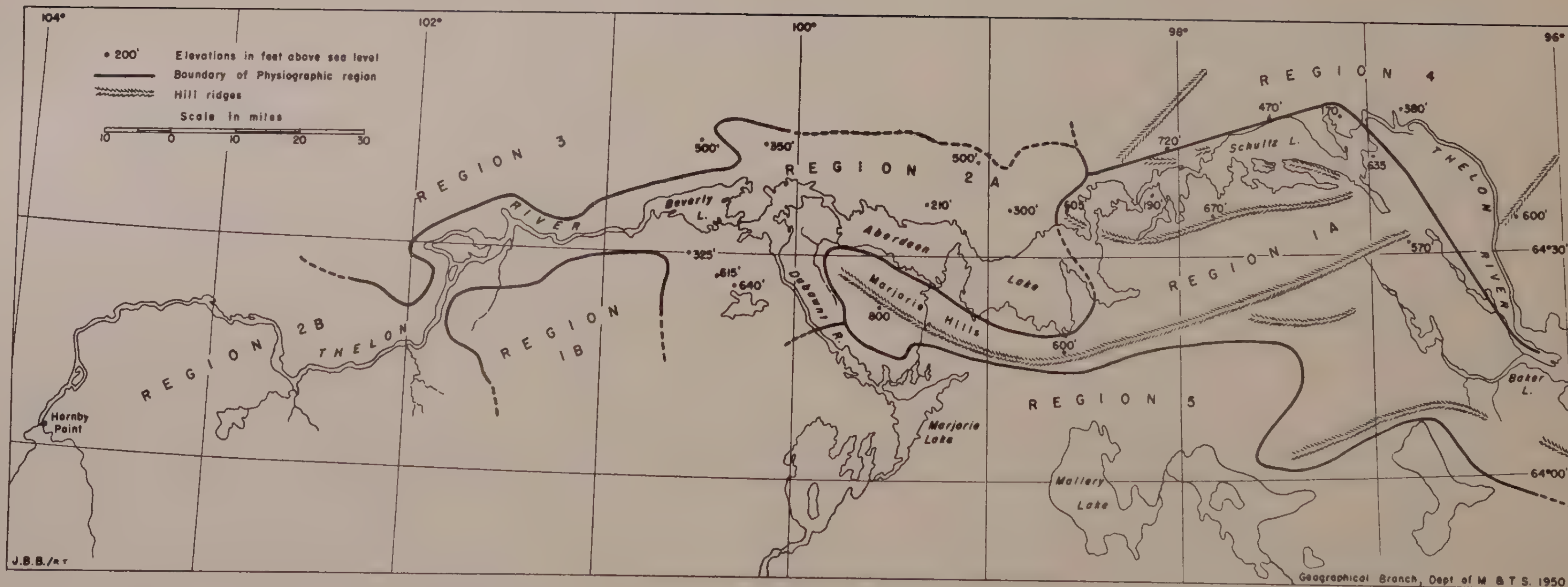

Figure 5. The physiographic sub-regions of the middle and lower Thelon Basin.

The climate is undoubtedly responsible for the slow rate of physical weathering in the Thelon Basin when compared with many arctic areas. Physical weathering by frost action proceeds most rapidly when the temperature is fluctuating about the freezing point of water. In Keewatin the rise in temperature in May and June and the fall in September and October is so fast that the period when the temperature is about 32°F. is very short. In addition, the precipitation is low (probably less than 9 inches) and the scanty snowfall, which usually supplies much of the moisture for freeze-thaw action, melts on exposed rock surfaces within a few days of the air temperature approaching 32°F.

The erosive power of running water is also limited in scope by the short season. The period of time that has elapsed since the Ice Age has been so short geologically that little stream erosion is found on hard rock. In the areas of till even small streams have cut gorges that attain depths of 130 feet between Aberdeen and Beverly Lakes. Under present climatic conditions the rivers transport considerable quantities of weathered material, but their efficiency in this respect is limited by the lakes along their courses, which act as traps for the material. This is particularly noticeable in the western half of Beverly Lake, which has been filled with sand brought down by the upper Thelon. In addition to transport by running water three other agencies become locally dominant. They are solifluction, wave action along the shores of the larger lakes, and wind transport in the sandy areas that lack a vegetation cover.

On the basis of the topography and the stage of physiographic development, it is proposed to divide the middle and lower Thelon Basin into five physiographic regions (Figure 5):

1. The ridge and valley region south of Aberdeen and Schultz Lakes.
2. The sandy till plain of the middle Thelon Basin.
3. The sandy till uplands.
4. The Central Keewatin plateau.
5. The Mallery Lake lowland.

1. The Ridge and Valley Region South of Aberdeen and Schultz Lakes

Region 1 is an area of longitudinal hill ridges and valleys that have developed on the Proterozoic sedimentary rocks. The ridges are composed of either quartzite or conglomerate and the intervening valleys have developed on sandstone. Although the pattern of the hills is complex, five main ranges may be recognized. The most northerly range forms the islands and peninsulas off the south shore of Schultz Lake. The second range begins in the northeast corner of Aberdeen Lake and continues to the east in a line of hills parallel with the south shore of Schultz Lake. Thelon River, at the point where it leaves Aberdeen Lake, cuts through this ridge in a shallow gorge. The third line of hills commences at the southeast

corner of Aberdeen Lake and extends eastwards to the abandoned valley of Thelon River. The fourth ridge begins a few miles east of the mouth of Dubawnt River and extending to the east it forms the southern boundary of the region for 60 miles. Although these hills are not conspicuous from Aberdeen Lake because of their gently convex north side, from the south they form a prominent scarp rising steeply from the plain of the lower Dubawnt River. South of Schultz Lake this ridge is lower than in the west, and finally becomes lost in complex hill ridges towards Baker Lake. The fifth range forms the southern boundary of the region in the east, and continues beyond the area under discussion to the mouth of Kazan River.

The altitude of the hill summits is very constant, varying between 600 and 650 feet south of Schultz Lake, rising to 725 feet northeast of Marjorie Lake and to 800 feet at the western end of the region. On the summit of Marjorie Hills there is an undulating surface of low relief, 14 square miles in area, at an average height of 725 feet. The older erosion surface in region 1 has been almost destroyed. The last vestiges of it are found in the concordant summit altitudes and the bevelling of the upper surfaces of the hills.

The sandstone in the valleys between the hill ridges is covered by a small and variable thickness of till, and by sand and by frost-shattered plates of sandstone. The sand, generally deltaic in origin, was washed down into the valleys by streams from the exposed hills when the region was partly submerged by Hudson Bay. Neither lakes nor large streams are numerous in the valleys, although the surface is frequently marshy and covered with hillock tundra. The east-west longitudinal pattern of the hills and valleys hinders movement overland from south to north and the native winter sledge routes are found to the east and west of the region.

Schultz Lake and Baker Lake form the northern boundary of the region in the east. The two lakes are over-deepened rock basins lying at the contact of the Archæan rocks on the north shore and the Proterozoic rocks to the south. The southern shores of both lakes are considerably shallower than the north shores where deep water exists immediately off the land.

Although region 1 ends at Dubawnt River, a sub-region (1a) with similar characteristics is found southwest of Beverly Lake. Here the land rises to over 800 feet in a group of quartzite hills. As regions 1 and 1a are divided by the valley of Dubawnt River, they are topographically distinct. Geologically, however, they are joined by a band of quartzite underlying the lowland near the mouth of the Dubawnt.

2A AND 2B. THE SANDY TILL PLAIN OF THE MIDDLE THELON BASIN

Thelon River between Dickson Canyon and Aberdeen Lake, and the lower Dubawnt River below Marjorie Lake, flow through a till-covered plain of low relief. The underlying rock rarely appears at the surface, but is thought to be Proterozoic sandstone throughout the whole region. The sandstone is covered by sandy till that contains few boulders and varies in

thickness from a few feet to over 135 feet. The till is in turn overlain by lacustrine and marine sands derived from it. From the scattered observations that were made of the absolute height of the sandstone above sea-level, it appears that prior to the last glaciation the relief was more subdued than at present, the unequal deposition of the till and the development of furrows in it having accentuated the relief. In the area where Finnie River enters the Thelon, the furrowing is very pronounced. The ridges between the furrows are about 20 feet high and are free of vegetation, whereas the furrows are poorly drained and covered with hillock tundra. The Thelon flows between banks of till in a shallow gorge. The streams tributary to the main river have cut deep narrow gorges in the till, making land travel difficult in some parts.

The presence of large quantities of sand, which in the better drained areas lack a continuous vegetation cover, has led to the formation of sand dunes. They are best developed around Tibielik River, where they cover 12 square miles and are over 80 feet high. Dunes are also found less extensively in the area bounded by the northward loop of the Thelon between Hornby Point and Finnie River.

Eskers are found on the plain but are not as numerous as in other parts of Keewatin. The eskers investigated were composed entirely of sand and it is probable that many formed during the closing stages of the Ice Age were destroyed by the submergence that followed. One very prominent landform of fluvioglacial origin has survived south of Beverly Lake. This consists of a line of hills composed of sand and pebbles that parallel the regional glacial flow and rise to 640 feet above sea-level. The glacial lake washed over the hills to give them a flat-topped appearance. As the lake fell by stages, it cut bluffs and platforms in the easily eroded sands. The hills are in many respects similar to Mount Pelly on Victoria Island[1]. J. B. Tyrrell notes similar landforms north of Dubawnt Lake[2]. Their origin is uncertain, but the hills south of Beverly Lake are probably deltaic in formation, laid down at the retreating ice front in the glacial lake.

Region 2 is divided into two parts by high land that approaches the Thelon from both the north and the south, 30 miles above Beverly Lake.

3. The Sandy Till Uplands

Region 3 has characteristics belonging to both regions 1 and 2. It is an area of low hills and valleys that developed prior to the glaciation of the region on Proterozoic sandstone. The summits of the hills rise to 500 feet above sea-level on the north side of Beverly Lake and 800 feet 15 miles to the north. Large quantities of sandy till were deposited by the ice in the valleys and on the sides of the hills. The result of the glaciation was, therefore, to subdue the relief, as only the higher parts of the hills now appear through the till.

[1] Washburn, A. L.: Reconnaissance Geology of Portions of Victoria Island and Adjacent Regions, Arctic Canada; Geol. Soc. Amer., Mem. 22, p. 53, Baltimore, 1947.

[2] Tyrrell, J. B.: op. cit., pp. 64-66.

The whole aspect of the region is one of great aridity, and Hanbury considered it to be the driest part of Northern Canada[1]. The vegetation throughout the region is sparse, areas of sand free of vegetation being common, particularly on the sides of hills. The streams are small and many flow in gorges cut in the till. The largest river in the region, the Tibielik, flows in a 100-foot gorge eroded in till, which fills a broad valley in the sandstone. During the late summer, Tibielik River is a shallow stream with a flow of less than 500 cubic feet per second.

The boundary between regions 2 and 3 is abrupt west of Tibielik River, but further east, north of Aberdeen Lake, the transition is less distinct.

4. The Central Keewatin Plateau

Region 4 is an area of low hills and rocky terrain north of Schultz Lake and east of the lower Thelon gorge. Basically the region is a plateau of Archæan rocks with an average height of 450 feet in the south, rising gradually to approximately 1,000 feet at the Thelon-Back River watershed. The plateau is crossed by hill ridges having a general northeast to southwest alinement, and which rise to 650 feet above sea-level in the south.

North of Schultz Lake the Archæan rocks are mainly granite-gneisses in which two sets of linears, at right angles to each other, are well developed. Those with a direction 160 to 340 degrees dominate the landscape. When the peneplain was rejuvenated after the formation of the earlier erosion surface, the fault lines that form the linears were eroded first to form straight, narrow valleys. The second lobe of the ice-sheet, during the final glaciation, over-deepened these valleys and blocked them with till and morainic boulders. The result is a series of elongated, narrow lakes, the largest of which, northwest of Schultz Lake, is 11 miles long and has a maximum width of 400 yards. The second set of linears is prominent only along the southern boundary of the region (north of Schultz Lake), where a fault-line scarp 200 to 400 feet high may be traced for 32 miles.

Till is only present in small quantities but boulder fields are extensive, covering much of the low-lying area. Many of the boulders exceed 6 feet in diameter and make travel by land in both winter and summer difficult.

East of the Thelon gorge, the granite-gneiss changes to schists. The landscape is less rugged, with considerable areas covered with till, and the linear pattern of the lakes is not as prominent as it is north of Schultz Lake.

5. The Mallery Lake Lowland

The hills in region 1, extending in an east-west direction for 130 miles, form a barrier to the rivers that flow in a north-northeast direction down the regional slope of the peneplain from southern Keewatin. Both Dubawnt and Kazan Rivers are deflected by the hills before entering the Thelon-Baker Lake waterway. After leaving Marjorie Lake, Dubawnt

[1] Hanbury, D. T.: Sport and Travel in the North Land of Canada; Edward Arnold, London, 1904, p. 119.

River is turned to the northwest and flows around the western end of region 1. Kazan River flows east for 30 miles before breaching the hills in a series of falls and rapids. Region 5 is the lowland that lies between the two rivers. As neither geologists nor geographers have visited the region, the details of the structure and topography are still little known. The underlying rocks are believed to be Proterozoic sediments covered with till and boulders. The landscape is one of low, rolling relief with an average altitude of 300 feet above sea-level. The most conspicuous features of the physiography are four large shallow lakes. Only the two western lakes (Marjorie and Mallery Lakes) have been named. In addition to the four lakes (two of which exceed 200 square miles in area) there are innumerable smaller lakes and the whole region has a juvenile drainage pattern.

RÉSUMÉ

Malgré l'accès assez facile de la région ouest de la baie d'Hudson, de vastes étendues demeurent encore inexplorées et inconnues. Depuis les premières expéditions et explorations dans le Keewatin, cette région fut classée comme faisant partie du bouclier canadien et subdivisée seulement en deux sous-régions: les hautes terres de l'intérieur et le domaine littoral. Les frontières ne peuvent être tracées cependant, avec certitude, car on réalise davantage, aujourd'hui, toute la complexité de l'évolution de la période glaciaire et post-glaciaire. Des études sur le terrain furent conduites, en 1948, par la Division de Géographie dans la région de Thelon, afin d'élucider la physiographie du Keewatin. On examina la géologie et les effets physiographiques de la glaciation à l'époque Pléistocène. L'auteur rapporte que l'évidence du mouvement de la glace dans le bassin Thelon, appuie la théorie d'une calotte glaciaire centrée dans la baie d'Hudson; il développe cette théorie, en référant aux traits glaciaires observés partout dans la région et à la modification du paysage par la glaciation. On enregistra les effets locaux du climat et, particulièrement, les effets du gel. D'après l'état actuel de la physiographie et de la topographie, le bassin du moyen et du bas Thelon est divisé en cinq régions physiographiques dont chacune est décrite en détail.

LE PORT ET L'ARRIÈRE-PAYS DE TROIS-RIVIÈRES

Pierre Camu[1]

Le port de Trois-Rivières, sur le Saint-Laurent au confluent de la rivière Saint-Maurice, n'occupe pas une situation aussi avantageuse que ceux de Montréal et de Québec. En amont, Montréal, installé aux pieds des rapides de Lachine, est devenu le grand port de transbordement entre la navigation intérieure du haut Saint-Laurent et des Grands lacs et la navigation océanique du bas Saint-Laurent, de l'estuaire et du golfe. En aval, Québec, avec son site admirable, offre le premier port de toute sécurité que les océaniques rencontrent en venant de l'Atlantique. Entre les deux, Trois-Rivières ressemble plus à un port d'escale qu'à un port d'origine et de destination du trafic. Cette situation moins favorable, n'empêche pas, cependant, le port de Trois-Rivières de devenir en 1936, par l'intensité de son trafic, le cinquième port du Canada, après Montréal, Vancouver, Halifax et Saint-Jean (Nouveau-Brunswick) et, de conserver ce rang depuis. La meilleure explication réside dans la récente croissance industrielle de son arrière-pays, en une des régions les plus progressives du Canada.

LE SITE

Le port primitif n'était qu'une plage de débarquement utilisée par les Indiens qui se rendaient à la foire de Trois-Rivières, l'une des plus considérables de l'époque. Quand Champlain remonta le fleuve, il choisit une petite "plate-forme de sable à trente-cinq pieds environ d'altitude et qui fut aussitôt appelée le Platon[2]", endroit idéal pour y construire un fortin à l'abri des inondations et dans un endroit sec. Cet emplacement original est situé sur la terre ferme près de l'embouchure ouest du Saint-Maurice, car le confluent du Saint-Maurice et du Saint-Laurent ressemble à un petit delta formé de trois couloirs ou "trois rivières", séparés par les îles du Saint-Maurice; le couloir de l'ouest étant le plus vaste. Cet endroit propice, reconnu comme tel par les Indiens avant l'arrivée des blancs, n'était pas seulement une croisée de chemins d'eau, mais encore une escale excellente avant ou après la traversée en canot, de cette longue et large nappe d'eau du lac Saint-Pierre en amont. Un peu plus tard, lorsque les frégates et corvettes françaises remontèrent le fleuve et que leurs quilles frottèrent les bas-fonds du lac Saint-Pierre, Trois-Rivières devint la tête de la navigation en eau profonde et le port le plus à l'intérieur qui pouvait être atteint sans trop de difficulté. On lit sur les cartes bathymétriques actuelles, juste en face du Platon et du site de la cité, des profondeurs de 50 et 60 pieds que l'on ne retrouve pas en amont dans le fleuve. Les marées à Trois-Rivières n'ont pas l'ampleur qu'elles ont encore à Québec, comme l'indique le

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[2] R. Blanchard: *Le Centre du Canada Français*. Montréal, 1948, p. 163.

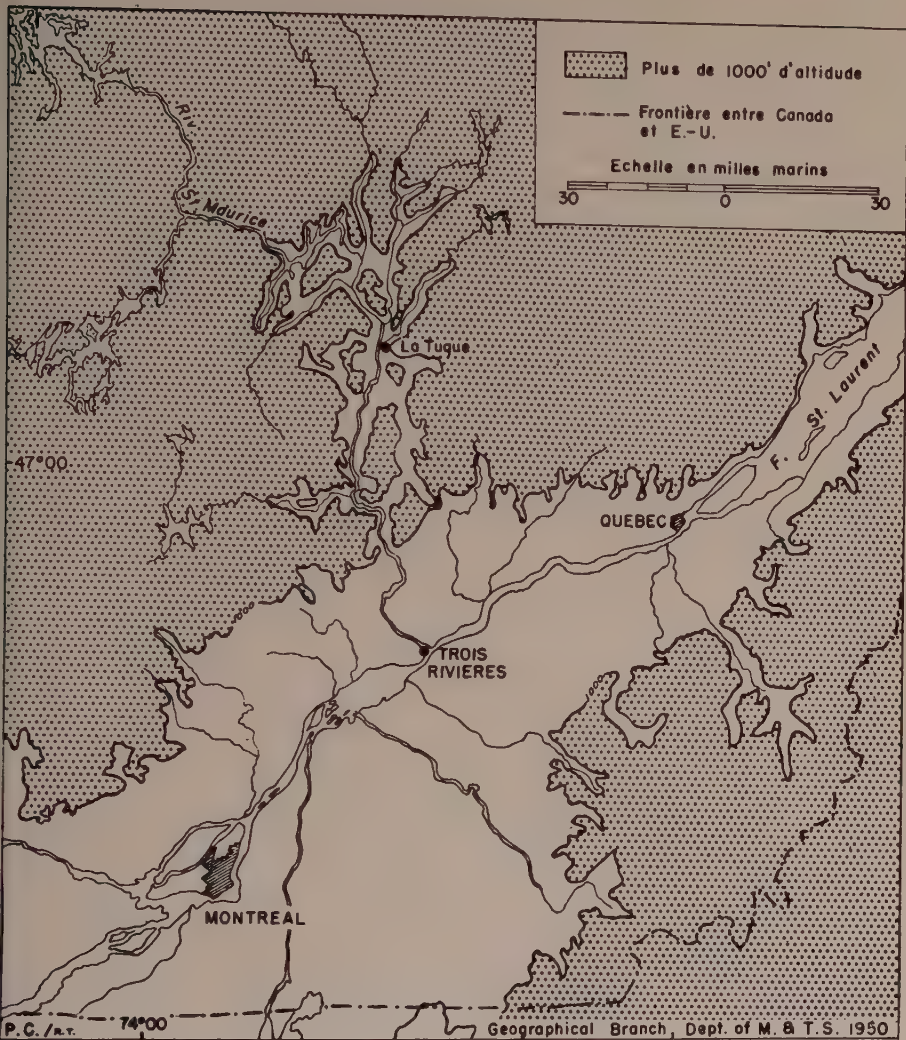

Figure 1. Vallées du bas Saint-Laurent et du Saint-Maurice. Trois-Rivières est située au confluent du fleuve et de la rivière.

tableau 1. C'est un autre avantage qui permet de construire des installations portuaires permanentes et moins coûteuses. De plus, le fleuve est assez large, soit plus d'un mille, pour que les navires circulent et même pivotent avec une certaine aisance. Il n'y a pas de courant rapide comme dans le port de Montréal (courant Sainte-Marie d'environ 6 nœuds[1]). Ces qualités nautiques, découvertes au fur et à mesure que le port se transformait, justifièrent l'emplacement du site primitif. Le port ne s'étend pas le long du Saint-Maurice qui sert au flottage du bois descendant des

[1] Sur l'hydrologie du fleuve à cet endroit et les qualités de son régime, on renvoie à un article de M. Maurice Pardé—"Hydrologie du Saint-Laurent et de ses affluents", dans *Rev. Can. de Géographie*, Vol. II, n[os] 2-4, 1949, pages 35-83.

concessions forestières de la région. D'ailleurs, les petits navires tels les chalutiers et remorqueurs, ne peuvent la remonter que sur quelques milles, jusqu'à un endroit appelé "La Gabelle", les premiers d'une série de rapides et chutes. A partir de 1920 à 1925, les qualités du site portuaire furent pleinement utilisées.

TABLEAU 1

INTENSITÉ DES MARÉES DANS LES PORTS DE TROIS-RIVIÈRES ET DE QUÉBEC. (PAR MOIS DE MAI À NOVEMBRE; MOYENNE DES ANNÉES 1930-1939)[1]

—	Mai		Juin		Juillet		Août		Sept.		Oct.		Nov.	
	H.	B.	H.	B.	H.	B.	H.	B.	H.	B.	H.	B.	H.	B.
Trois-Rivières....	9·1	4·4	6·1	2·6	4·5	1·5	3·8	0·8	3·5	0·2	0·4	0·3	0·1	0·5
Québec...........	19·8	0·6	19·1	0·5	18·8	18·6	18·5	0·1	18·5	0·1	19·0	0·7	19·3	0·6

Source: *Dept. of Transport: Information concerning the River St. Lawrence Ship Channel from Father Point to Montreal including tide Tables. Montreal to Lake Ontario and the Ottawa River.* Ottawa, 1948, p. 19.

L'ÉVOLUTION DU PORT

Trois-Rivières était tout désigné pour devenir une grande foire indienne. Chaque année, après la fonte des neiges, les Indiens descendaient en canot le Saint-Maurice vers Trois-Rivières, afin d'échanger leurs produits de chasse avec d'autres tribus qui venaient du haut Saint-Laurent et d'ailleurs. Les Français s'y installèrent avec l'espoir de monopoliser cette fonction commerciale qui pouvait être fort lucrative. Ils y réussirent d'ailleurs, mais pas à Trois-Rivières, car les guerres iroquoises (1637-1655) détruisirent l'économie de la vallée du Saint-Maurice, route qui drainait aussi les produits de chasse d'une partie des territoires de la baie d'Hudson. Les Iroquois poursuivirent les Hurons, alliés des Français, jusque dans leurs domaines les plus reculés de la vallée. Les Français détournèrent le trafic des fourrures, par la voie plus éloignée et moins menacée du Saguenay, vers le port de Tadoussac. Le port de Trois-Rivières subit également la concurrence de nouveaux ports, tels Sorel et Montréal; ce dernier devint en peu de temps l'un des grands postes de traite de la vallée de l'Ottawa et du haut Saint-Laurent. Si le trafic des fourrures n'a jamais cessé en entier à Trois-Rivières, il était tout de même très réduit.

L'arrière-pays immédiat de Trois-Rivières connut le premier développement industriel du Canada, à un endroit appelé: "les Vieilles Forges" et situé à sept milles environ au nord-ouest du port, non loin du Saint-Maurice. On transformait en métal la limonite extraite des marais avoisinants et, on exportait par le port ces produits de fonte et de fer fabriqués irrégulièrement, de 1737 à 1883[2]. Ainsi, l'arrière-pays de Trois-Rivières qui s'étendait,

[1] Ces marées indiquent la moyenne des plus hauts et des plus bas niveaux à marée haute et basse respectivement. Les hauteurs sont au-dessus des données des cartes.

[2] R. Blanchard: op. cit., p. 157.

au début, à toute la vallée du Saint-Maurice et à une grande partie du bassin de la baie d'Hudson, fut coupé dès 1658, par ces guerres iroquoises; le port perdit sa fonction commerciale et ne garda qu'une fonction industrielle irrégulière et faible. Pendant plus de deux siècles, le port exerça une fonction de port d'escale. "Ces deux siècles d'existence paisible et médiocre témoignent que, quand le Saint-Maurice se ferme, Trois-Rivières, réduite à la seule vie du fleuve, n'est qu'un organisme au ralenti[1]."

Le port de Québec durant toute cette période, de 1608 aux environs de 1870, était la porte d'entrée et de sortie du Canada, et Trois-Rivières, l'un des anneaux de cette chaîne de carrefours qui couvrait le pays. Même le départ de Trois-Rivières de grands explorateurs comme la Vérendrye et de fameux coureurs des bois comme Radisson et des Groseilliers, n'assombrit pas le lustre de Québec. Montréal, qui grandissait sans cesse, livra sa "bataille pour le port" et procéda, au 19e siècle, au dragage du fleuve et au creusement d'un chenal maritime de plus en plus profond, si bien qu'en 1870, le chenal navigable entre Québec et Montréal atteignait 22 pieds de profondeur et une moyenne de 200 pieds de largeur. Le pôle principal de l'axe économique du Saint-Laurent se déplaça de Québec à Montréal; Québec perdit un vaste arrière-pays au profit d'un rival situé plus à l'intérieur. Entre les deux, Trois-Rivières ne changea pas; plus de navires passaient devant ses quais, la circulation maritime s'activa mais le port n'avait rien à offrir d'alléchant et ne participait pas encore au trafic de cette grande voie de circulation.

De 1870 à 1900, la région de la vallée du Saint-Maurice, appelée joliment "La Mauricie" et dont Trois-Rivières en est le port, s'éveilla à nouveau à la vie industrielle. Deux développements parallèles et complémentaires infusèrent une nouvelle vie régionale; celui des produits de la forêt, l'une des grandes ressources naturelles du Canada, et celui de l'énergie hydroélectrique[2]. L'exploitation des produits de la forêt s'effectua en deux périodes successives, la première, lors de l'établissement de scieries le long de la rivière Saint-Maurice et à Trois-Rivières, de l'expédition de pin blanc et de bois de construction vers l'Europe et les États-Unis (1840-1880), la deuxième, une période de transition, suivie d'un progrès décisif dans l'exploitation des forêts et la transformation du bois, en pâte d'abord (en 1890 à Grand-Mère) et en papier ensuite (en 1898 à Grand-Mère encore). Après 1900, d'autres pulperies et moulins à papier s'installèrent dans la région, à La Tuque, Shawinigan, Trois-Rivières et au Cap-de-la-Madeleine. En 1898, on équipa les chutes de Shawinigan, premier pas dans

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[1] Ibid., p. 167.

[2] Au sujet de l'essor de l'industrie hydroélectrique dans cette région et dans le Québec en général, voici deux références: B. Brouillette: "Combustibles et Force Motrice", dans *Notre Milieu*, Montréal, 2e éd., 1946, pages 233-270.

A.-B. Normandin: *Quebec's Undeveloped Water Powers* dans *The Engineering Journal*, Vol. 32, n° 11, novembre 1949, pages 727-735.

Sur l'essor de l'industrie forestière: B. Brouillette: "L'industrie des Pâtes et du Papier" dans *La Forêt*, Montréal, 1949, pages 172-231.

le harnachement des eaux du bassin du Saint-Maurice en l'une des rivières les mieux exploitées du continent nord-américain. L'énergie hydroélectrique attira sur place des industries chimiques, textiles et autres. Le commerce, les services et les transports se greffèrent sur cette activité industrielle pour constituer une région productrice et, un arrière-pays qui avait besoin d'un point d'appui maritime, d'un port. Les tendances économiques et industrielles de la région étaient tracées dès 1920; elles s'amplifieront par la suite. L'arrière-pays, en se transformant, ouvrait à nouveau le port de Trois-Rivières. Une nouvelle période commence, celle du port moderne lié à la circulation maritime du fleuve, qui possède un rayonnement maritime intéressant et participe de plus en plus à l'économie canadienne.

L'ADMINISTRATION ET LA DESCRIPTION DU PORT

On créait, en 1885, la Commission du port de Trois-Rivières qui administra le port pendant plus de cinquante ans. Quelques années après la publication du rapport Gibb, sur le fonctionnement des ports canadiens, soit en 1936, on créait le Conseil des ports nationaux, institution fédérale qui groupait sous une seule administration les ports de Montréal, Vancouver, Halifax, Saint-Jean (Nouveau-Brunswick), Québec, Trois-Rivières, Chicoutimi et Churchill, en plus du pont Jacques-Cartier à Montréal et des élévateurs à grain de Prescott (Ont.) et de Port-Colborne (Ont.)[1]. Cette réorganisation plaçait le port de Trois-Rivières sous la direction immédiate d'un gérant du port; à partir de cette date toutes les statistiques du trafic sont données en tonnes de 2,000 livres[2]. De plus, les limites du port étaient explicitement décrites telles qu'elles apparaissent sur la figure 2[3]. La description légale se déchiffre ainsi: à l'ouest, la limite correspond à une ligne tracée parallèle à une ligne qui s'étend d'un point sur la rive nord, séparant les limites paroissiales de Trois-Rivières et de Pointe-du-Lac, à un point sur la rive sud qui rencontre les limites paroissiales de Nicolet et de Saint-Grégoire; au nord, la limite du port correspond au prolongement de la limite de la cité, vers l'autre rive du Saint-Maurice; à l'est, la limite du port n'est que le prolongement de la limite de la cité à travers le Saint-Laurent jusqu'à la rive sud. Toutefois en 1938, par proclamation royale, la limite de l'est était reportée à une ligne qui joignait la pointe de Lottinville sur la rive nord à la pointe de Bécancour sur la rive sud[4]. Le port dans sa plus grande longueur mesure donc 10·7 milles légaux, mais le havre lui-même se réduit à une ligne de quais et de hangars d'environ un mille, en excluant les quais individuels du Cap-de-la-Madeleine et de Sainte-Angèle-de-Laval.

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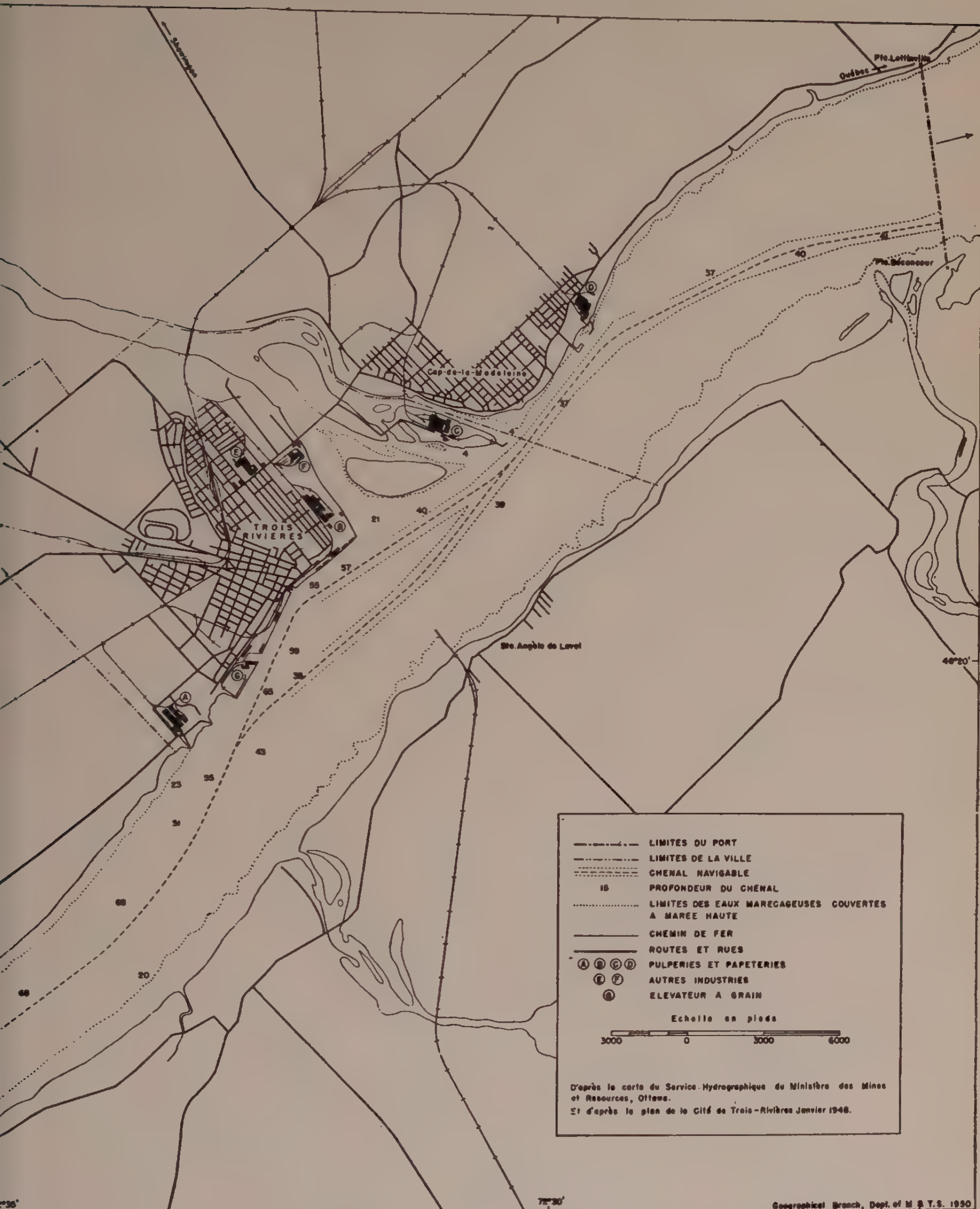
[1] A. Gibb: *National Ports Survey 1931-32* (Report), Ottawa, 1932, 180 pages.

[2] Les données statistiques de 1920 à 1935 présentées en boisseaux, cordes, briques, tonnes ou barils ont toutes été recomptées en tonnes (2,000 liv.), afin de faciliter les comparaisons annuelles et de suivre l'évolution du trafic du port.

[3] I Edward VIII, chap. 42, *An Act respecting The National Harbours Board*, p. 19.

[4] C.P. 106, 13 juillet 1949.

On a employé les mots "rive sud et rive nord" alors que souvent elles sont orientées est et ouest. Mais c'est une vieille coutume locale de les désigner ainsi. Il serait plus juste de dire rives droite et gauche.



Le port de Trois-Rivières et ses limites. Les limites du port ont été décrites dans le texte à la 34. Cette figure indique aussi l'emplacement exact des principaux quais, hangars et industries le long du bord de l'eau et dans le voisinage du port. Sur la rive gauche on a, successivement: A, la *awrence Paper Mills, Ltd.*, le parc à charbon, le bassin de l'élévateur à grain, les quais à messageries; *Canadian International Paper Company*; C, la Division *Wayagamack*, le quai du Cap; D, la Division -Maurice. Ces deux pulperies, C et D, sont la propriété de la *Consolidated Paper Corporation* qui de également les pulperies et papeteries de Shawinigan-Falls et de Grand-Mère. Dans la ville de Trois-Rivières on a, en E, la *Wabasso Cotton Company, Ltd.*, et en F, la *Canada Iron Foundries*, Sur la rive droite, le quai de Sainte-Angèle-de-Laval. Les traversiers font la navette entre ce et un point de la rive gauche situé entre les profondeurs 55 et 57 pieds.

Le port est des plus modernes et offre tous les services essentiels, tels que ceux détaillés dans le tableau 2. Ces différentes installations furent construites entre 1920 et aujourd'hui, dont l'une des plus importantes, l'élévateur à grain, fut parachevée en 1936.

TABLEAU 2

INSTALLATIONS PORTUAIRES DE TROIS-RIVIÈRES

1. Chemin de fer du port. Longueur en milles	5	5. Capacité de l'entrepôt frigorifique en milliers de pieds cubes	100
2. Nombre de quais (5 en comptant ceux de Sainte-Angèle et du Cap)	3	6. Capacité de l'élévateur à grain en millions de boisseaux	3
3. Longueur des quais en pieds	8,690	7. Capacité du chargement du grain à l'heure (en 000′ de boisseaux)	32
4. Superficie des hangars en milliers de pieds carrés	192	8. Capacité du parc à charbon en milliers de tonnes	300

Source: *Annuaire du Canada 1948-1949*, p. 719.

LA SAISON DE NAVIGATION

Ce port moderne, comme ses rivaux sur le Saint-Laurent, n'est pas ouvert toute l'année à la navigation mais quelque sept mois et demi, soit d'avril à décembre. Le tableau 3 donne les dates extrêmes de la saison de navigation à Montréal. Pendant plus de 230 jours, le port de Trois-Rivières est ouvert à la navigation océanique et intérieure, période pendant laquelle s'effectue tout le trafic du port. Un certain trafic de transit s'effectue toute l'année, celui des bateaux-passeurs entre les deux rives qui, en même temps qu'ils traversent passagers, automobiles et camions, brisent la glace et assurent un chenal permanent d'une rive à l'autre.

TABLEAU 3

DATES D'ARRIVÉE ET DE DÉPART DU PREMIER ET DU DERNIER OCÉANIQUE À MONTRÉAL. Moyennes de 1920 à 1946

Années	Première arrivée	Dernier départ	Nombre de jours ouverts à la navigation
1920-1939	avril 21	décembre 7	230
1940-1946	avril 30	décembre 10	224
1949	avril 7	décembre 8	245

Sources: *The River Saint-Lawrence Ship Channel*, p. 11. *The Saint-Lawrence Survey. Part II Shipping Services on the St. Lawrence River*, p. 14. (*U.S. Dept. of Commerce*, Washington 1941, N. R. Danielan, *Director of the Survey*.)

LE TRAFIC DU PORT

Le trafic du port est analysé dans les figures 3, 4, 5 et 6; les deux premières indiquent le nombre de navires et leurs tonnages de jauge nette arrivés dans le port, de 1920 à 1948, les deux dernières montrent les tonnages des cargaisons chargées et déchargées dans le port, selon la direction et la provenance, de 1920 à 1948.[1]

[1] Ces figures ont été construites à l'aide des rapports annuels suivants:
De 1920 à 1935: *Three Rivers Harbour Commissioners' Reports*, Trois-Rivières, 1920-1936.
De 1936 à 1948: *Rapport annuel du Conseil des Ports Nationaux*, Ottawa, 1936-1948.

L'allure générale des courbes des figures 3 et 4 ressemble à une sinusoïde avec hauts et bas, à intervalles irréguliers. Ces fluctuations correspondent assez bien à ce que les économistes appellent des "cycles économiques", soit des périodes de prospérité entrecoupées de périodes de dépression et de crise et, ce que beaucoup d'autres appellent plus simplement, les bonnes et mauvaises années. On pourrait dire du port de Trois-Rivières que les bonnes années s'écoulèrent de 1925 à 1930, de 1935 à 1940 et, de 1945 à aujourd'hui, qu'entre ces années s'intercalèrent la crise et la guerre. Les courbes de la figure 3 se reflètent sur les autres figures, plus ou moins atténuées, par exemple des navires qui ne seraient qu'à demi chargés ou vides, augmentent le nombre de navires, mais diminuent le tonnage des cargaisons et font changer la valeur des courbes. Néanmoins, on constate que le port de Trois-Rivières est sensible à l'instabilité de la vie économique et des marchés mondiaux, cette sensibilité n'est pas aussi vive que dans le cas du port de Montréal, fréquenté par un plus grand nombre de navires océaniques qui le relient plus étroitement aux courants commerciaux internationaux. C'est la première constatation qui se dégage de la figure 3, car le nombre de navires de haute mer ou longs-courriers arrivés à Trois-Rivières, et nommés désormais océaniques, n'équivaut qu'à 10 p. 100 du total, soit 100 à 150 arrivages par année. Les navires d'eaux intérieures, nommés à l'avenir caboteurs, représentent le reste, soit 80 à 90 p. 100 du total et pour la seule année de 1948, le plus grand nombre de caboteurs jamais arrivés dans le port, 2,945. Le tonnage net enregistré des navires qui arrivent où leur jaugeage dessine une ligne brisée semblable à celles de la figure 3. Les tonnages des océaniques comptent pour 200,000 tonnes, avec l'année-record de 539,000 tonnes en 1945. Le tonnage des caboteurs s'est maintenu depuis 1926, au-dessus d'un million de tonnes avec une moyenne de 1·2 à 2 millions de tonnes selon les années. Si l'on compare le nombre à la jauge des caboteurs, on trouve une moyenne de 890 tonnes nettes par navire, tonnage qui se rapproche de celui des caboteurs des Grands lacs, avec des jauges nettes de 700 à 750 tonnes. Cet estimé est fort raisonnable, car Trois-Rivières n'est ni un port de pêche ni un port de plaisance et ne possède pas de petites embarcations qui augmentent le nombre de navires mais diminuent la jauge. Le mouvement des navires dans le port, surtout celui des caboteurs, donne l'impression d'un gros port régional vivant d'un commerce interrégional.

Les figures 5 et 6 permettent de préciser davantage les fonctions portuaires et le rôle joué par le port. Les lignes brisées de la figure 5 ressemblent à celles des figures précédentes avec des augmentations ou des diminutions les mêmes années. Cependant, cette figure indique quelque chose de plus, soit une augmentation régulière du tonnage global des cargaisons manutentionnées dans les limites du port.

Ainsi le tonnage global augmenta de 157,000 tonnes en 1920, à 2,568,000 tonnes en 1948. Cette augmentation générale se produisit d'une façon irrégulière: 1° une augmentation radicale de 1926 à 1930, qui correspond à un développement industriel sans précédent de l'arrière-pays, 2° une chute

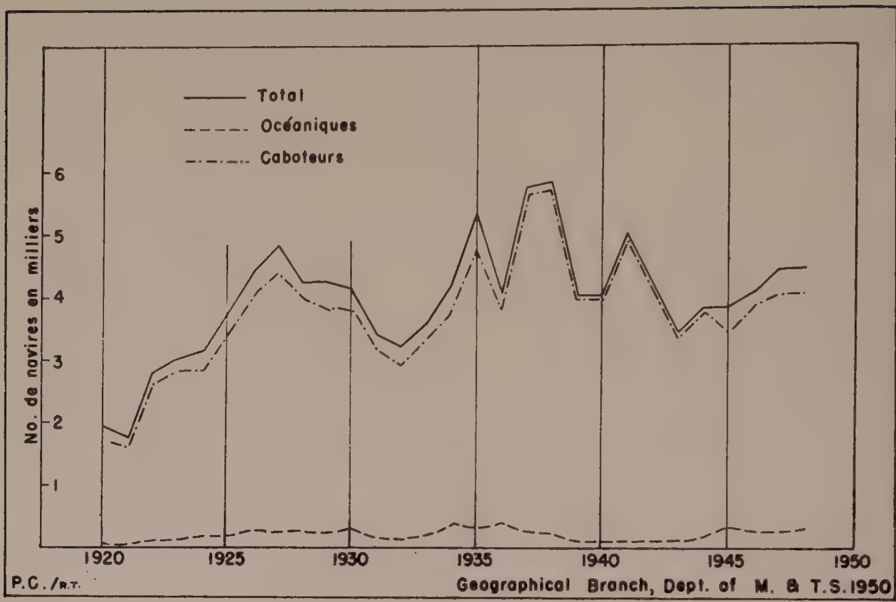


Figure 3. Nombre de navires arrivés dans le port de 1920 à 1948.

(Figures 3-6. Diagrammes montrant le trafic du port de Trois-Rivières. *Voir* renvoi page 36.)

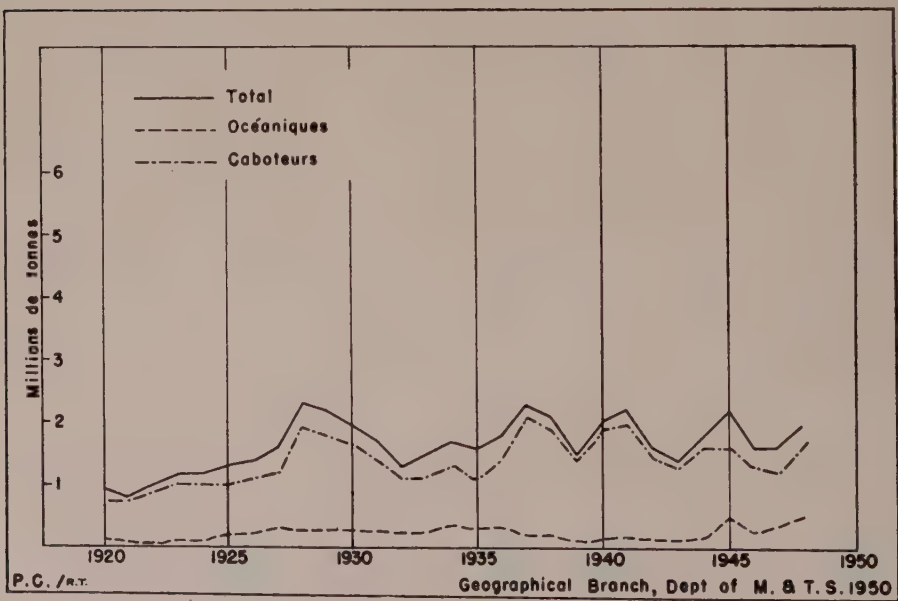


Figure 4. Tonnage net enregistré ou jauge nette des navires arrivés dans le port de 1920 à 1948.

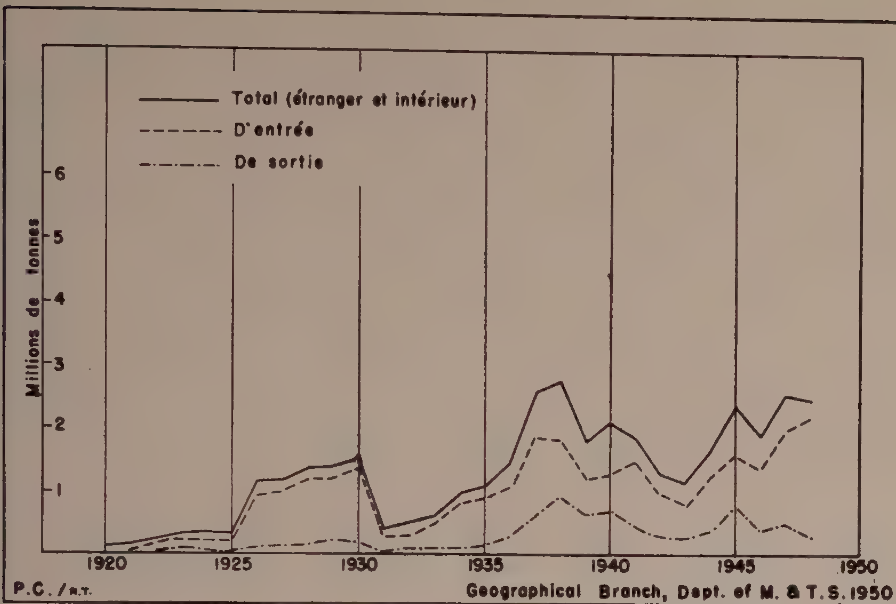


Figure 5. Tonnage et trafic des cargaisons dans le port de 1920 à 1948.

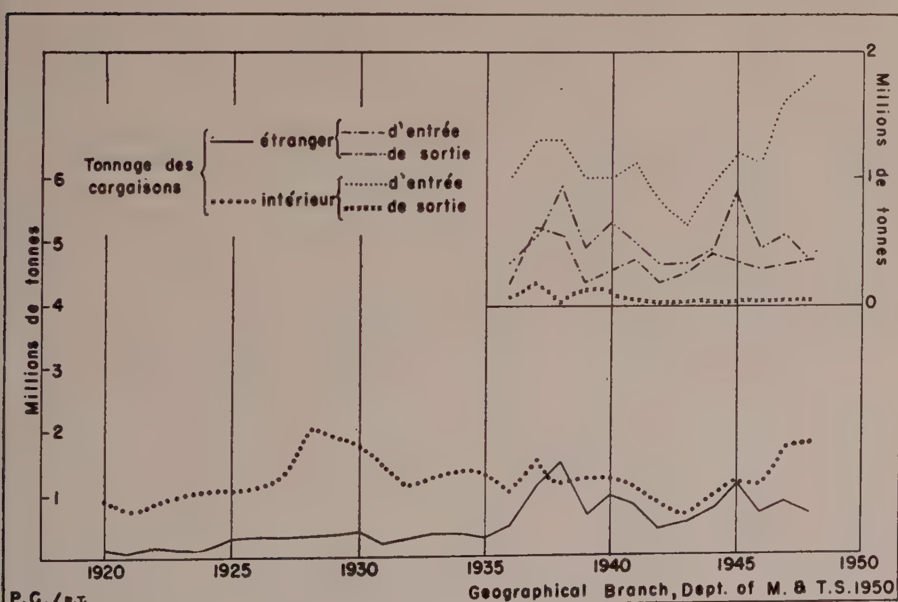


Figure 6. Mouvement des cargaisons dans le port de 1920 à 1948, avec détails pour les années 1936-1948.

subite en 1931, avec le début de la crise et des tonnages aussi réduits que 250,000 tonnes par année, ce qui dépasse toutefois, en quantité, les tonnages des années 1920 à 1925, 3° une reprise des affaires suivie de la deuxième augmentation de 1936 à 1940 qui correspond à la mise en opération du nouvel élévateur à grain et l'enregistrement du plus fort tonnage de denrées manipulées dans le port, soit 2,861,545 tonnes en 1938, 4° deuxième chute due à la guerre de 1942 à 1945, 5° reprise du trafic après la guerre. En comparant ce tonnage global avec celui des autres ports canadiens, le port de Trois-Rivières occupe le rang suivant: 1925 (5^e), 1928 (6^e), 1930 (4^e), 1931 à 1936 (6^e), 1937 et 1938 (3^e), 1939 à 1942 (5^e), 1943 (6^e), et 1944 à 1948 (5^e); des quatre ports du bas Saint-Laurent, on peut dire qu'il vient immédiatement après Montréal depuis 1936, et avant Québec et Sorel[1]. (Québec en 1943 enregistra cependant un plus fort tonnage que celui de Trois-Rivières[2].) Les importations constituent presque toujours la plus grande partie du tonnage global des marchandises; les volumes des denrées entrées dans le port, de 1926 à 1930, représentent, en moyenne, 85 p. 100 du tonnage global, et après la construction de l'élévateur à grain, de 1936 à 1940, environ 60 p. 100; car le grain qui arrive par eau et par rail est expédié entièrement par eau, ce qui augmente le volume des exportations. Depuis 1945, les importations représentent, à nouveau, une moyenne de 78 p. 100 du tonnage, mais avec des quantités supérieures, telle l'année 1948 avec plus de 2·2 millions de tonnes de denrées. Les exportations de 1920 à 1935 forment un total annuel de 200,000 tonnes, mais dès que le trafic du grain débute en 1936, elles augmentent à près de 500,000 tonnes par année, atteignant un sommet d'un million de tonnes en 1938. La figure 5 permet déjà de discerner les fonctions portuaires, celles d'un port importateur et qui importe de plus en plus.

La figure 6, en analysant les tonnages des cargaisons selon la provenance soit d'origine étrangère ou domestique ou intérieure, précise davantage ces fonctions[3]. Le trafic intérieur est plus considérable que le trafic étranger. Cette supériorité quantitative a diminué depuis 1936 et fut même dépassée en 1938, lorsque les envois de grain atteignirent le million de tonnes. (1·5 million de tonnes en tout.)

Depuis 1935, le mouvement de ce trafic étranger et intérieur est subdivisé en importations et exportations. (*Voir* le détail de figure 6.) Les importations, presque en entier, appartiennent au trafic intérieur, excepté quelque 50,000 tonnes de marchandises qui sortent du port pour être expédiées ailleurs au Canada, tandis que les exportations font partie du trafic étranger. Le port de Trois-Rivières est donc surtout un port importateur de produits domestiques et, exportateur de produits locaux, livrés à l'étranger. La qualité des importations et des exportations finalement va déterminer les véritables fonctions portuaires.

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[1] La liste de ces ports est donnée précédemment et n'inclut que ceux du Conseil des ports nationaux.

[2] Ces calculs furent établis d'après un calcul comparatif des tonnages totaux gracieusement fournis par le Conseil des ports nationaux.

[3] Le tonnage des cargaisons classé "étranger" fait partie du commerce international arrivant de ou partant pour des ports étrangers. Le tonnage des cargaisons classé "domestique" fait partie du commerce interrégional arrivant de ou partant pour des ports nationaux.

TABLEAU 4

IMPORTATIONS PAR LE PORT DE TROIS-RIVIÈRES AU COURS DES ANNÉES 1928, 1934, 1938, 1944 ET 1948, EN MILLIERS DE TONNES

—	1928	1934	1938	1944	1948
Bois à pâte et de construction	671	23	700	692	1,394
Charbon (bitumineux)	437	388	310	418	511
Grain	–	–	783	120	192
Soufre	17	35	–	–	26
Gazoline	10	5	16	13	23
Huile et pétrole	20	20	30	40	13
Marchandises générales	52	55	62	29	49
	1,207	526	1 ,900	1,312	2,209

Sources: *Three Rivers Harbour Commissioners' Reports for the years 1928, 1934. National Harbour Board* (*Annual Report*), années 1938, pages 47-48; 1944, p. 41; 1948, p. 40.

Les tableaux 4 et 5 indiquent les importations et exportations au cours d'années choisies pour leur particularité; 1928, année de prospérité, 1934, lendemain de crise, 1938, année-record, 1944, année de guerre, 1948, dernière année; ce choix conserve une certaine progression qui permet de suivre l'évolution du port. Les importations se composent de cinq groupes de denrées, ce sont par ordre d'importance: 1° les produits de la forêt, surtout le bois à pâte importé des concessions forestières de la Gaspésie et de la Côte Nord du Saint-Laurent, afin d'alimenter en matières premières une industrie en expansion, 2° le charbon bitumineux importé autrefois de la Nouvelle-Écosse, et maintenant des États-Unis, vient compléter en énergie et combustible les sources hydroélectriques régionales, 3° le grain importé par eau et par rail des prairies canadiennes et réexporté vers l'Europe, 4° les produits pétrolifères importés des raffineries montréalaises, pour les besoins de la consommation locale et régionale, et 5° les marchandises générales. Les exportations se réduisent à deux denrées principales, le papier à journal, véritable produit de la région, exporté surtout vers les États-Unis et le Royaume-Uni, et le grain; les autres produits sont

TABLEAU 5

EXPORTATIONS PAR LE PORT DE TROIS-RIVIÈRES AU COURS DES ANNÉES 1928, 1934, 1938, 1944 ET 1948, EN MILLIERS DE TONNES

—	1928	1934	1938	1944	1948
Papier à journal	94	132	158	12	84
Grain	–	–	785	208	246
Sable	64	6	–	–	–
Bois de construction	–	8	2	103	–
Bois à pâte	11	–	–	37	–
Marchandises générales	23	18	16	67	28
Totaux	192	164	961	427	358

Sources: les mêmes que celles du tableau 4.

irréguliers et ne comptent que pour un faible pourcentage du tonnage global. Ces deux tableaux permettent maintenant de préciser les fonctions portuaires: la première et la plus importante est une fonction industrielle qui fait de Trois-Rivières un port importateur de matières premières comme le bois à pâte, le charbon, le soufre, etc., venues d'autres régions du pays et des États-Unis, afin d'alimenter un arrière-pays industriel et, un port exportateur de produits finis dont le papier à journal, vers d'autres pays; la deuxième, une fonction commerciale, le grain. Ce sont des fonctions bien définies mais inégales quant à leur qualité et quantité. Par exemple, les exportations sont faibles, seul le papier à journal compte comme production venant de l'arrière-pays et, ce produit ne peut attirer un trafic suffisant et rémunérateur pour des lignes régulières de navigation. En première réponse à cette carence de fret de retour et, pour diversifier les exportations, on créa une fonction commerciale, le transbordement du grain, fonction qui varie en intensité avec les années, selon la concurrence des ports de Montréal, de Sorel et de Québec. Cette fonction commerciale qui n'affecte et n'intéresse que le port de Trois-Rivières, sera expliquée maintenant, tandis que la fonction industrielle le sera plus loin dans la partie sur l'organisation de l'arrière-pays.

Le commerce du grain à Trois-Rivières varie beaucoup avec les années; cela ne dépend pas uniquement des récoltes annuelles des prairies canadiennes, mais aussi de la situation géographique du port. Les élévateurs à grain de Trois-Rivières, de Sorel et de Québec, furent construits pour aider les ports à diversifier leurs fonctions et procurer du fret de retour aux navires qui s'amarraient à leurs quais. Tous ces élévateurs sont des concurrents directs de ceux du port de Montréal. Ils n'offrent qu'un avantage particulier, car ils ont les mêmes taux et supportent les mêmes coûts d'opérations (excepté l'élévateur privé de Sorel), cet avantage est d'épargner un temps précieux aux océaniques qui attendraient, à l'ancre, leur tour de s'approcher des quais du port de Montréal; c'est une solution à la congestion du trafic dans ce port, à certaines périodes de l'année, en particulier au début et à la fin de la saison de navigation après les récoltes de blé d'hiver et de printemps.

TABLEAU 6

Trafic du grain dans le port de Trois-Rivières de 1936 à 1948, en millions de boisseaux

Années (moyennes)	Arrivages	Expéditions	Total
1936-1940	15·2	14·7	29·9
1938	(29·7)	(28·4)	(58·1)
1941-1945	9·3	9·3	18·6
1942	(3·2)	(3·1)	(6·3)
1946-1948	8·6	9·2	17·8

Source: *National Harbours Board, Annual Report for 1939*, p. 39; *1945*, p. 41; *1948*, p. 42.

Figure 7. Vue aérienne d'une des pulperies de Trois-Rivières; cette vue correspond à(a) de la figure 2. (Photo C.P.R.)

Figure 8. Vue de la section ouest du port de Trois-Rivières. (Photo C.P.R.)

Le tableau précédent (n° 6) donne une idée des arrivages et des expéditions de grain à Trois-Rivières de 1936 à aujourd'hui. On a inséré dans le tableau 6 les années 1938 et 1942 qui sont les minimums et maximums enregistrés jusqu'ici et qui corrigent partiellement les moyennes. Quatre-vingt-dix-neuf pour cent du grain est expédié par eau, mais il en arrive toujours certaines quantités par rail. Ces quantités varient de 17 millions de boisseaux à 6·6 millions durant la guerre (1944). En 1939, sur 166 tramps qui quittent Montréal sur lest, 26 trouvent du fret de retour (soit surtout du grain) à Trois-Rivières, ce qui démontre comment la fonction commerciale du port a su tirer un certain profit de la grande circulation qui passe sur le fleuve[1].

Il existe aussi un trafic de transbordement un peu spécial, c'est celui des bateaux-passeurs au nombre de trois, en opération 24 heures par jour, toute l'année, et qui relient Trois-Rivières à Sainte-Angèle[2]. Ils transbordent d'une rive à l'autre, passagers, automobiles et camions; ces derniers apportent du bois à pâte des forêts de la rive sud aux usines de pâte et de papier situées dans les limites de la ville. Un autre aspect du trafic des voyageurs est celui des navires fluviaux qui s'arrêtent quelquefois au quai du Cap-de-la-Madeleine, endroit de pèlerinage réputé, et assurent un service régulier de fret entre Montréal, Trois-Rivières, Québec et les ports de l'estuaire.

Voici quelques statistiques sur le trafic entre les deux rives de 1946 à 1949:

Années	Passagers	Véhicules avec conducteur
1946	675,726	166,332
1947	709,190	187,300
1948	760,190	235,727
1949	759,297	250,738

Source: Lettre personnelle du Trésorier de la cité en date du 11 janvier 1950.

Les fonctions portuaires de Trois-Rivières sont maintenant connues mais encore confuses, car chacune de ces fonctions joue un rôle différent dans l'économie du port. On a décrit tantôt les fonctions industrielles et commerciales et tantôt les fonctions locales et régionales. Ces fonctions s'enchevêtrent les unes aux autres, d'où une double classification s'impose, que l'on emprunte à M. Marcel Amphoux[3]. Il classe les fonctions portuaires en *ratione materiæ*, d'après l'activité économique du port, par exemple fonction industrielle et fonction commerciale et, *ratione loci*, d'après la situation que le port occupe dans l'espace, fonction locale, régionale, nationale et internationale. *Ratione materiæ*, le port de Trois-Rivières possède deux fonctions distinctes, d'abord industrielle, port importateur de

[1] Benoit Brouillette: "Le port et les transports" dans *Montréal économique*, Montréal, 1942, p. 151.
[2] L. Allen: "Le port de Trois-Rivières", thèse M.A., Université Laval, Québec, 1944, p. 21.
[3] M. Amphoux: "Les Fonctions Portuaires" dans *La Porte Océane*, Vol. V, n° 53, septembre 1949, pages 9-11.

matières premières et ensuite, commerciale, trafic du grain; ces deux fonctions ont été commentées en partie. *Ratione loci*, le port de Trois-Rivières est-il un port régional, national ou international; c'est ce qui reste à discerner. Si l'on s'en tient au nombre et au jaugeage des navires arrivés dans le port, on le considère comme un port surtout régional, si, au contraire, on considère le trafic des cargaisons entrées et sorties et leur provenance, le port peut être classé comme semi-régional et semi-international. On ne peut pas dire que c'est un port national, dans le sens que son trafic pénètre ou s'étend à toutes les régions naturelles et économiques du pays, car son trafic est surtout régional et n'est relié qu'à deux régions canadiennes, les Prairies, par le grain de l'Ouest et, la région de l'estuaire et du golfe Saint-Laurent, par la pulpe. Les seules denrées qui participent à des courants de commerce internationaux sont le charbon importé et le papier et le grain exportés, ces trois item équivalent environ à 50 p. 100 du trafic total des cargaisons. En excluant le blé, presque tout le trafic s'échange avec un seul pays, les États-Unis, et c'est ce qui donne quelquefois la fausse impression d'un trafic entièrement régional, parce que les États-Unis sont voisins et que le charbon, si important dans le trafic du port, est acheminé par la voie maritime du Saint-Laurent et des Grands lacs, sur des caboteurs presque tous canadiens. On ne retrouve pas, comme dans les ports européens même de deuxième ordre ou comme à Montréal, des consignations et des denrées composées d'objets les plus hétéroclites et venant de toutes les parties du monde. Malgré cette allure brusque et nette de son trafic et, un rayonnement maritime limité à un arc de cercle qui s'étend depuis Port-Arthur et Fort-William, au fond du lac Supérieur, jusqu'à Baltimore, dans le fond de la baie de Chesapeake, le port de Trois-Rivières participe à un commerce international plus qu'intéressant. (Il faut ajouter ici le trafic du grain vers le Royaume-Uni, autre lien extra-national.) Le port possède une autre fonction d'après le site qu'il occupe dans l'espace, ou *ratione loci*, mais cette fois-ci, en tenant compte de son arrière-pays, c'est une fonction régionale qui correspond à une région décrite plus loin. Pour M. Amphoux, les fonctions portuaires locales, régionales ou internationales sont tracées d'après les limites de l'arrière-pays; on croit, cependant, qu'elles doivent être définies également d'après les relations maritimes où le rayonnement maritime du port. Telles sont les fonctions portuaires de Trois-Rivières, *ratione loci*, ou d'après le lieu qu'il occupe[1]. Toutes ces fonctions, industrielle, commerciale, régionale et internationale mettent en évidence une économie portuaire simplifiée, mais dangereuse. Le danger, c'est le manque de diversité du trafic; que le mouvement de l'une des denrées s'arrête, le grain par exemple ou le charbon, et tout le trafic du port s'en ressent. On peut constater d'un autre côté, qu'un port à fonction

[1] Les méthodes qui permettraient de définir clairement toutes ces fonctions sont encore au stade d'expérimentation; on ne possède pas des formules établies ou des systèmes détaillés. Dans la nouvelle revue française, *La Porte Océane*, on a commencé la publication d'une série d'articles qui servent d'introduction à l'étude des ports. Les économistes eux-mêmes se sont toujours concentrés sur le facteur "temps" et, ce n'est que récemment que le facteur "espace" attira leur attention. Alfred Weber, Bertil Ohlin et Edgar J. Hoover sont parmi les premiers. Voici une référence récente sur le sujet par Walter Isard: "*The General Theory of Location and Space Economy*", dans le *Quarterly Journal of Economics*, Vol. LXIII, n° 4, novembre 1949, pages 476-506.

Figure 9. Vue aérienne de l'embouchure du Saint-Maurice avec au centre, l'île de la Potherie, et à droite, vue partielle du Cap-de-la-Madeleine. (Photo C.A.R.C.)

Figure 10. Shawinigan-Falls. (Photo C.N.R.)

Figure 11. Vue aérienne de Shawinigan-Falls, avec le Saint-Maurice en bas à gauche et au centre à droite. *(Photo (c) Photographic Surveys (Quebec) Limited.)*

Figure 12. Vue aérienne de la ville de Grand-Mère, avec la pulperie et papeterie ainsi que l'usine hydro-électrique au centre et légèrement à droite. *(Photo (c) Photographic Surveys (Quebec) Limited.)*

industrielle dominante est moins sensible qu'un port à fonction commerciale, aux sursauts économiques de l'heure. Les cinq figures qui ont traduit la vie du port de Trois-Rivières, sont en général dessinées de lignes moins brisées que celles du port de Montréal, aussi pourrait-on dire qu'un port est affecté par les changements économiques mondiaux de deux façons: directement, quand le trafic océanique et extérieur prime, indirectement, quand c'est le cabotage. Montréal vit aussi le commerce de son port diminuer d'une façon subite durant la crise de 1930 à 1933 et la guerre toute récente de 1940 à 1944, et refleurir durant les années plus prospères de 1926 à 1930 et 1936 à 1938, car Montréal était directement rattaché à un plus grand réseau de circulation et d'échanges commerciaux; que la chaîne réagisse et tous les noyaux vibrent. Le port de Trois-Rivières réagit indirectement, il reflète les tendances de l'économie canadienne qui reflète, à son tour, celles du monde, ce qui est une autre façon de reconnaître à ce port, une fonction régionale dominante.

Jusqu'ici, on a étudié deux aspects du port de Trois-Rivières, soit le noyau ou le port lui-même avec son site, son passé, ses installations et son trafic et, le rayonnement maritime, sa façade ouverte sur le fleuve et la mer. Le rayonnement maritime forme l'une des deux composantes de l'équation de circulation d'un port, l'autre est l'arrière-pays, appelé par les Allemands *hinterland*, ce qui s'ouvre derrière le port[1]. C'est le moment de tracer les limites de l'arrière-pays de Trois-Rivières.

L'ARRIÈRE-PAYS

Cette notion d'arrière-pays est encore confuse et l'on ne possède pas de définition reconnue, on pourrait la définir comme "l'ensemble du réseau de relations reliant le port à la portion de continent qu'il dessert[2]"; ou bien, selon Morgan, un port possède jusqu'à trois arrières-pays différents, 1° l'arrière-pays importateur qui comprend tous les coins de pays ou zones qui importent des denrées par le port, 2° l'arrière-pays exportateur qui comprend tous les coins de pays ou zones qui exportent par le port, 3° l'arrière-pays de base qui groupe sur une même carte les arrières-pays importateurs et exportateurs[3].

L'arrière-pays de base correspond rarement à l'arrière-pays naturel. L'arrière-pays naturel de Trois-Rivières s'étend sur deux régions naturelles décrites ainsi: (*voir* figure 13) la région de Trois-Rivières qui, "sur la rive gauche du fleuve, s'étend à l'est jusqu'à la Pérade, à l'ouest, jusqu'à Louiseville", sur la rive droite, "elle touche juste Saint-Pierre-les-Becquets, passe par Sainte-Anne-du-Sault, Saint-Wenceslas, Sainte-Brigitte, Saint-Zéphirin, Pierreville[4]." Cette région fut légèrement étendue et dévint la

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[1] J. Gottmann: "Baltimore: un grand port industriel" dans *La Porte Océane*, Vol. V, n° 52, août 1949, 1re partie, pages 11-16.

[2] Ibid, p. 12.

[3] Morgan les appelle: *import, export and basic hinterland.* Ces définitions du texte sont nôtres mais l'idée fondamentale est la même et on en est redevable à Morgan. *Voir* F. W. Morgan. *The Pre-War Hinterlands of the German North Sea Ports* dans *Transactions and Papers 1948.* (*Institute of British Geographers*) publication n° 14, Londres 1949, pages 45-55.

[4] R. Blanchard: op. cit., p. 173.

Figure 13. Carte montrant la région, la plaine et l'arrière-pays de Trois-Rivières.

plaine de Trois-Rivières[1]. Au nord de cette première région naturelle, s'étend la vallée de la rivière Saint-Maurice, de Shawinigan à La Tuque et davantage. Le centre d'attraction naturel de ces deux régions serait la ville et le port de Trois-Rivières, mais la région économique est plus réduite et ses limites décrivent le cercle imparfait suivant: (selon l'aiguille d'une montre et par le site de villages, villes et cités qui apparaissent sur la figure 13) Shawinigan, Sainte-Anne-de-la-Pérade, Victoriaville, Nicolet et Louiseville. L'agglomération urbaine de Shawinigan-Grand-Mère s'impose de plus en plus comme le grand carrefour de la vallée du Saint-Maurice

[1] B. Brouillette: "Les régions géographiques de la Province de Québec" dans *Notre Milieu*, Montréal, 1946, pages 41-51.

et dispute déjà à Trois-Rivières, une partie de sa plaine. Enfin, le véritable arrière-pays de base qui contribue pour plus de 90 p. 100 à la vie du port, se réduit à un groupe de villes où sont localisées toutes les industries de la région: Trois-Rivières, Cap-de-la-Madeleine, Shawinigan et Grand-Mère. Toutes les zones agricoles sont exclues, elles ne participent pas du tout à la vie du port, ainsi que la rive sud ou droite, à l'exception d'un demi-cercle de 30 à 35 milles de rayon de Sainte-Angèle, en-dedans duquel proviennent par camion quelques milliers de tonnes de pulpe, pour les pulperies et papeteries de Trois-Rivières, trafic qui ne rapporte rien au port lui-même. Cette zone métropolitaine ayant la forme d'un rectangle de 25 milles de longueur, est habitée par une population de 170,000 habitants (estimé de 1947). Cet arrière-pays de base possède 174 industries manufacturières de toutes dimensions, qui produisirent pour une valeur nette de 64 millions de dollars en 1946 (tableau 7). Les grandes industries, cependant, celles qui sont vitales à l'économie du port, se réduisent à 32; elles produisent environ 90 p. 100 de la valeur globale mentionnée au tableau 7[1].

TABLEAU 7

DISTRIBUTION GÉOGRAPHIQUE DES INDUSTRIES DANS L'ARRIÈRE-PAYS DE BASE DU PORT DE TROIS-RIVIÈRES (1946)

—	Nombre d'établissements	Valeur nette de la production en milliers de dollars[2]
Trois-Rivières	78	29,070
Cap-de-la-Madeleine	28	1,659
Shawinigan	40	25,586
Grand-Mère	28	8,522
	174	64,837

Source: *Geographical Distribution of the manufacturing industries of Canada*, 1946, Ottawa, 1948, 64 pages. D.B.S. Publication, pages 11, 17.

TABLEAU 8

INDUSTRIES EMPLOYANT PLUS DE 50 PERSONNES ET SITUÉES DANS L'ARRIÈRE-PAYS DU PORT DE TROIS-RIVIÈRES (1947)

—	Pulpe et papier	Textiles	Fer et métaux	Produits chimiques	Autres	Total
Trois-Rivières	3	6	1	–	1	11
Cap-de-la-Madeleine	1	4	1	–	–	6
Shawinigan	1	2	1	5	–	9
Grand-Mère	1	3	–	–	2	6
	6	15	3	5	3	32

Source: *Inventaire Économique et Industriel de Trois-Rivières, Cap-de-la-Madeleine, Shawinigan et Grand-Mère.* Ministère de l'Industrie et du Commerce de la Province de Québec. Rapports polycopiés, 1947 et 1948.

[1] La Tuque, sur le haut Saint-Maurice, possède une grosse usine de pulpe et de papier qui se ravitaille à même les réserves forestières environnantes et reçoit aussi certaines quantités de pulpe par chemin de fer, tous les transports s'effectuent par flottage, drave et chemin de fer et une infime quantité seulement participe au trafic du port. Comme c'est la seule grosse usine importante de la région, à cause de discrétion, les statistiques sur la production sont tenues confidentielles.

[2] La valeur nette de la production est la différence entre le coût des matériaux et matières premières plus le coût de l'électricité et du chauffage moins la valeur brute.

Cet arrière-pays de base comprend un arrière-pays importateur où sont logées les 32 usines plus ou moins importatrices de matières premières, soit de pulpe ou de produits chimiques ou de combustibles comme le charbon, et un arrière-pays exportateur qui se réduit aux 6 usines de pulpe et de papier (soit 4 à Trois-Rivières et au Cap-de-la-Madeleine sur le bord du fleuve et une à Shawinigan et à Grand-Mère, sur le bord du Saint-Maurice)[1]. Cet arrière-pays de base constitue l'autre composante de l'équation de circulation du port, soit une région assez restreinte et à économie simplifiée. L'arrière-pays potentiel est vaste, riche et plein de promesses mais il échappe au trafic du port de Trois-Rivières; on l'a signalé précédemment, le manque de fret de retour est le point faible de l'économie portuaire. D'autres moyens de transport plus efficaces sont entrés en compétition avec les transports par eau et, peu à peu ont accaparé le trafic régional et l'ont détourné de son point d'appui naturel, le port. Que l'on compare le trafic du port à celui de son arrière-pays et l'on constate cette emprise qu'ont les chemins de fer par exemple, et même aujourd'hui le camion, comme modes de transports essentiels dans l'arrière-pays de base.

On abandonne les matières premières moins coûteuses et qui viennent de loin, telles le charbon et la pulpe, aux transports par eau (la fonction industrielle du port l'a démontré), mais le rail et la route monopolisent le transport des produits manufacturés, semi-finis et plus coûteux (la carence d'exportations dans le port appuie ce fait)[2]. En 1948, sur 1,004,590 tonnes de papier à journal produites par les 6 usines régionales, seulement 84,264 tonnes ou 8 p. 100 étaient expédiées par le port, tout le reste de ce trafic (92 p. 100) était transporté surtout par chemin de fer[3]. Le tableau 9 indique d'une autre manière l'importance des chemins de fer comme modes de transport dans l'arrière-pays exportateur. Les 2 usines de l'intérieur reçoivent leur matière première par voie du Saint-Maurice et du chemin de fer et expédient par rail. Les chemins de fer évitent les transbordements,

TABLEAU 9

MODES DE TRANSPORT EMPLOYÉS PAR LES 4 USINES DE PULPE ET DE PAPIER DE LA RÉGION DE TROIS-RIVIÈRES EN 1948

Modes de transport	Importations (%)	Exportations (%)
Par bateau	29·6	8·0
Par chemin de fer	36·2	90·0
Par camion	3·6	2·0
Par voie du Saint-Maurice (flottage)	30·6	–
Total	100·0	100·0

Sources: Enquête personnelle conduite à l'été de 1948 grâce à un octroi du Conseil Canadien des Recherches en Sciences Sociales. P. René de Cotret—*Monographie Industrielle de Trois-Rivières*. Thèse M. Com., École des Hautes Études Commerciales, Montréal, 1949, 53 pages.

[1] Sur le développement industriel de la pulpe et du papier *voir*: B. Brouillette—"L'industrie des Pâtes et du Papier"—dans *La Forêt*, Montréal, 1944, pages 172-231.

[2] On ne possède pas malheureusement de statistiques sur la valeur du trafic des cargaisons dans le port. Les chiffres que l'on compile sont ceux des cargaisons qui passent aux douanes; quantité insignifiante du trafic total.

[3] Renseignement donné par la section des forêts du Bureau fédéral de la Statistique.

sont plus rapides et opèrent toute l'année à des taux, il est vrai, légèrement supérieurs à ceux du transport routier et maritime mais, vite compensés par les autres facteurs. Les camions ont monopolisé plutôt le commerce de gros et de détail et les services. En somme, même si la plus grande partie de l'arrière-pays exportateur, celle qui rapporte le plus d'un point de vue financier, échappe au trafic du port, le reste de cet arrière-pays de base qui y participe quand même, demeure la raison d'être majeure du port de Trois-Rivières.

CONCLUSION

Cette étude serait incomplète si l'on omettait d'écrire un mot sur la situation financière du port. Le port, avec son organisation et son trafic, est une entreprise profitable, le tableau 10 en rend compte; mais il indique aussi le déficit quasi-annuel qu'il enregistre après déduction des intérêts et de la réserve de renouvellement. Ce n'est pas un problème insoluble, cela prendra encore de nombreuses années avant d'amortir complètement la dette originale. De tous les ports administrés par le Conseil des ports nationaux, Trois-Rivières, avec sa fonction commerciale et industrielle et son arrière-pays limité, est l'un des plus payants. Et c'est en développant ces fonctions, que le port de Trois-Rivières continuera d'être une entreprise rémunératrice à tous points de vue.

TABLEAU 10

RECETTES ET FRAIS D'EXPLOITATION DU PORT DE TROIS-RIVIÈRES, EN MILLIERS DE DOLLARS DE 1926 À 1948

Moyenne	Recettes d'exploitation	Frais d'exploitation	Revenu d'exploitation	Déficit net (*)
de 1926 à 1930	70·7	32·2	38·5	–
de 1935 à 1941	175·0	35·3	139·7	95·4
de 1945 à 1948	244·0	38·5	205·5	13·0

(*) Mais deux surplus furent enregistrés cependant, +5, en 1945 et +3, en 1947.

Sources: *National Harbours Board, Annual Reports, 1936-1948. Three Rivers Harbour Commissioners' Reports, 1926, 1935.*

Selon l'activité économique qui l'anime, la fonction commerciale et de transit ne pourrait être primordiale dans le cas du port de Trois-Rivières, à moins que son arrière-pays ne grandisse au point de créer une demande et une offre assez élevées, pour entretenir un courant commercial direct, sans passer par d'autres régions économiques, comme celle de Montréal par exemple. Alors le tonnage des marchandises générales augmenterait; mais c'est une question de temps, et d'ici plusieurs décennies, le port et la ville de Montréal continueront encore, sans doute, d'influencer le commerce régional de la Mauricie. Le trafic saisonnier et irrégulier du grain rapporte beaucoup au port de Trois-Rivières; ce fut un début de réponse au problème

du fret de retour et à la carence d'exportations. Est-ce que ce trafic, complément nécessaire aujourd'hui au trafic portuaire, disparaîtrait avec la canalisation du Saint-Laurent? On le croit de moins en moins et il semble que les ports du bas Saint-Laurent non seulement conserveraient leur fonction de transbordement, mais encore qu'elle serait plus active, ce qui favoriserait le transit du blé à Trois-Rivières[1].

La fonction industrielle est plus vitale encore. Si l'arrière-pays de base grandit, le port de Trois-Rivières croît. Un facteur physique a nuit récemment à la croissance industrielle des villes de Trois-Rivières et du Cap-de-la-Madeleine, ce sont les fondations sablonneuses qui empêchent l'installation de vastes usines à machinerie lourde, au profit des villes de Shawinigan et de Grand-Mère qui reposent sur le roc. Cette deuxième zone urbaine possède une chance de plus de progresser davantage demain, car elle a déjà un autre atout fort utile, un esprit jeune, pionnier et dynamique que l'on rencontre plus ou moins à Trois-Rivières. C'est à la porte de la vallée du Saint-Maurice plus que dans la plaine de Trois-Rivières que réside l'arrière-pays potentiel du port. Que la poussée industrielle continue et l'on verra augmenter les importations de matières premières; que l'on trouve d'autres marchés de papier à journal situés plus loin en Europe, aux États-Unis ou en Amérique du Sud et la distance en favorisant le transport par eau, accroîtra les exportations de papier par le port; que l'on diminue certains frais de transbordement et l'on déviera vers les quais certaines quantités de denrées transportées uniquement par rail aujourd'hui, enfin, que l'on crée dans l'arrière-pays de nouvelles industries surtout lourdes et la fonction industrielle s'activera. Quant au projet de canalisation du Saint-Laurent, son effet serait nul sur la fonction industrielle du port, car le fleuve est déjà canalisé en amont jusqu'à Montréal et, ce n'est pas la grande circulation maritime qui passe devant ses quais mais plutôt le développement de son arrière-pays industriel qui alimente le trafic actuel du port et qui l'alimentera demain.

Selon sa situation, c'est grâce à ce même arrière-pays, si le port de Trois-Rivières a connu tour à tour une fonction au début nationale et même impériale, puis pendant longtemps locale, et aujourd'hui régionale et même internationale.

L'importance, la renommée et l'avenir du port de Trois-Rivières résident dans cet arrière-pays naturel, aux possibilités nombreuses, de la plaine de Trois-Rivières et surtout de la vallée du Saint-Maurice.

[1] Voici deux références récentes sur ce sujet et qui émettent cette nouvelle opinion: *Dept. of Commerce, (U.S.A.) Industry Report—An Economic Appraisal of the St. Lawrence Seaway Project* (août-nov. 1947). Senator Wiley's report: *Potential Traffic on the St. Lawrence Seaway. Committee Print, 81st Congress, 1st Session*, déc. 1948.

Figure 14. (Sur les deux pages suivantes.) Vue aérienne verticale du port et de la ville de Trois-Rivières, du Cap-de-la-Madeleine, et d'une partie de Sainte-Angèle. Échelle approximative de 1,320 pieds au pouce. (Photo C.A.R.C.) →

SUMMARY

The harbour of Three Rivers on the lower St. Lawrence River is the fifth harbour of Canada. Its traffic increased from 100,000 tons of commodities in 1920 to a recent yearly average of over 2,000,000 tons.

The explanation of such a growth and progress is partly due to the industrial development of the St. Maurice River Valley, the back country of the harbour of Three Rivers, which is often called the hinterland of the port. This region, which contains such industrial centres as Grand-Mère, Shawinigan Falls, Cap-de-la-Madeleine, and the city of Three Rivers, was once renowned for its wildness and its difficulty of access. It has been transformed, however, into a very progressive region due mainly to its rich hydro-electric power potentialities and to the pulp and woodpulp reserves that form the basic raw material of the pulp and paper industry. The harbour of Three Rivers became the outlet of the regional output and the entrance for products and cargoes required by an increasing industrial demand. An analysis of the traffic of the port stresses the structure and the life of the harbour in relation to its hinterland or "the area that utilizes the port for both the export and the import of commodities, services, and even ideas".

The harbour has four functions: (1) An industrial function that consists of imports of raw materials for the needs of local manufacturing industries; (2) a commercial one in which the main activity is the transhipment of grain at the local elevator; (3) a regional function indicating that the harbour serves, first, its immediate area and then links the region with other Canadian regions, like the Prairies Provinces, Gaspe Peninsula, and the North Shore (Que.); (4) an international function indicating that Three Rivers expands its traffic outside of Canada and has direct contacts with foreign countries, instanced by the trade with the United States and the United Kingdom.

These four functions have been described from the viewpoint of the harbour itself as a nucleus and its network of maritime relations or its traffic with the rest of the world. Each harbour forms an equation composed of the harbour itself, and on one side the maritime relations or the open door to the sea and on the other side the hinterland.

Figure 13 shows the limits of the region, the plain and the hinterland of Three Rivers. The hinterland has been divided into three hinterlands: the import, export, and basic hinterlands. The basic hinterland groups the first two together, and, as Figure 13 shows, it is a small area, including, however, the four main centres enumerated above. The potential hinterland is a larger one and covers the whole St. Maurice River Valley, which is still in course of development. This region is often called today "La Maurice".

PEDOGEOGRAPHY OF CANADA

Donald F. Putnam[1]

Canada with nearly 4,000,000 square miles, or 7 per cent of the earth's surface, under the jurisdiction of one government would appear to be an ideal place for the development of pedogeography[2]. Especially as, for three-quarters of a century, the dominant economic activity of the country was agricultural and the greatest aim of government was the peopling of empty spaces. It is also a fact that this same period saw the rise and development of modern soil science in other parts of the world. Canada has not been lacking in the introduction of new crop varieties and in the investigation of agronomic techniques, but the natural advantages of the country for an early development of soil science were neither utilized nor appreciated.

No agricultural explorations whatever seem to have been carried out by the French before installing their original colonies in the Maritime Provinces and Quebec. The English on becoming masters of the country seem to have been equally disinterested in the agricultural possibilities. Even when faced with the relocation of tens of thousands of displaced persons after the American War of Independence the only technique available was to slice the forest into 100 acre lots, regardless of the quality of the soil. The evidence of multifold mistakes and heartbreaks is with us yet.

The westward expansion of Canada into the lonely wastes of Ruperts Land was to some extent preceded by exploration. Not only had a colony been established, although with great difficulty, in the Red River Valley, but expeditions were sent out to view the land beyond. During the years 1857 to 1860, the British Colonial Office maintained a party in the field under Captain John Palliser with instructions to examine the land with an eye to settlement. The Government of Canada also maintained men in the field, most notable among them being S. J. Dawson and the naturalist, Professor H. Y. Hind. Later, when surveys were being made for the Canadian Pacific railway another Canadian naturalist, Professor John Macoun, explored the country. Their reports are reviewed at length by Mackintosh[3], and as these data must already be familiar to most geographers they will not be given further space here. Suffice it to say that the few references made to the soil convey very little information about its characteristics or potentialities.

The establishment of agricultural experimental stations by the Canadian Government, and the founding of the Ontario Agricultural College in 1874, led to soil study, including investigations of tillage and fertility.

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[2] Pedogeography—geography and geographical significance of soils in much the same sense as phytogeography is used by geographers in dealing with plants.

[3] Mackintosh, W. A.: Prairie Settlement, the Geographical Setting; Canadian Frontiers of Settlement, Vol. 1. Macmillan, Toronto. 1934. XV-242 pp.

Various theories[1] were developed under the tutelage of Rothamstead and the shadow of Liebig, in which soil physics and soil chemistry played an important part. Soil genesis and soil geography were hardly considered at first, but eventually the example of the U.S. Soil Survey and the absolute need for such knowledge led to the beginning of similar work in Canada.

P. C. Stobbe, Soils Specialist with the Dominion Department of Agriculture, has recently reviewed the progress of soil surveys in Canada and the writer has drawn largely from his account[2]. Canadian soil survey work was initiated by the Ontario Agricultural College in 1914, and after numerous vicissitudes a preliminary account of the southwestern part of the province was published. It is chiefly of historical interest, however. About 10 years later, under the impulse provided by a developing tobacco-growing industry, soil survey work was begun on a county basis, and the Norfolk county map was published in 1927. Soil survey work was started in Alberta and Saskatchewan by the respective agricultural colleges in 1921 after a period of widespread crop failure. The Manitoba Agricultural College began organized soil surveys in 1927, and the first soil survey in British Columbia was begun in the irrigation areas in 1931. During the years 1927-30 Macdonald College carried on soil classification in Quebec. In 1934 surveys were started in market garden areas in Quebec and in the apple-growing areas of the Annapolis Valley of Nova Scotia. The first soil survey in New Brunswick was commenced in 1938, and in Prince Edward Island in 1943. A number of soil survey bulletins and reports on small areas were issued by the government of Newfoundland before it became a province of Canada. Soil surveys are at present conducted in all provinces by the co-operation of the provincial Departments of Agriculture, the Agricultural Colleges, and the Experimental Farms Service of the Dominion Department of Agriculture.

The early soil surveys in Canada, as in the United States, were mainly on a textural and geological basis. As the surveys in each province were separately initiated and controlled, the early reports show little correlation and "Consequently it has been difficult, especially for the uninitiated to obtain a comparative country-wide picture of soil conditions by studying survey reports from individual provinces"[3]. Up to the present, however, that is the way in which it must be done[4]. These differences and difficulties will be gradually ironed out by the headquarters staff at Ottawa and by the work of the National Soil Survey Committee, which has, since the recent war, begun to meet periodically, thus bringing together for conference and consultation the workers from the separate provinces[5].

Several types of soil surveys are conducted in Canada. As much of Canada is still unsettled and unmapped it is of importance to know which areas might contain soils worth further investigation. For this purpose a

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[1] Kellogg, Charles E.: Conflicting Doctrines about Soils; Scientific Monthly, vol. 66, pp. 475-487 (1948).
[2] Stobbe, P. C.: Soil Surveys in Canada; Agricultural Institute Review, No. 3, pp. 208-212 (1948).
[3] Stobbe, P. C.: op. cit., p. 209.
[4] *See* section on soils contributed by the writer *in* Canada by Griffith Taylor. Methuen, London, 1947.
[5] Proceedings of the First Conference of the National Soil Survey Committee; held at the Central Experimental Farm, Department of Agriculture, Ottawa, Ontario, May 7-11, 1945.

preliminary or broad reconnaissance survey is used. Traverses are made at fairly wide intervals, airplane flights are made, and the data plotted on fairly small scale maps. Such methods are useful in northern frontier areas, and over 75,000,000 acres have been studied in this way.

The bulk of the work has been done on the ordinary reconnaissance, or as it is called in Ontario, detailed reconnaissance scale. This scale varies, primarily because of the variation in base maps. In the Prairie Provinces these are available, for the most part, only on a scale of 3 miles to 1 inch, whereas in the eastern provinces topographic maps on a scale of 1 inch to 1 mile are available. In such areas, usually well settled, traverses are made at intervals of half a mile and along all roads. For special purposes detailed surveys have been made of over 2,000,000 acres on a scale of 4 inches (or more) to 1 mile.

The total area covered by all types of soil survey in Canada amounts to about 214,000,000 acres, as shown on the accompanying map (Figure 1). Of this about 135,000,000 acres are occupied and 77,000,000 acres are improved farm land. There remain over 35,000,000 acres of occupied land, including 14,000,000 acres of improved land, of which no soil surveys of any kind have yet been made. Only forty-three soil survey reports have yet been issued, although the material is in hand for a number of others and several maps have been issued without accompanying reports. This is a small volume of literature to compare with the results of the United States soil survey, yet in terms of resources inventoried it constitutes a creditable effort.

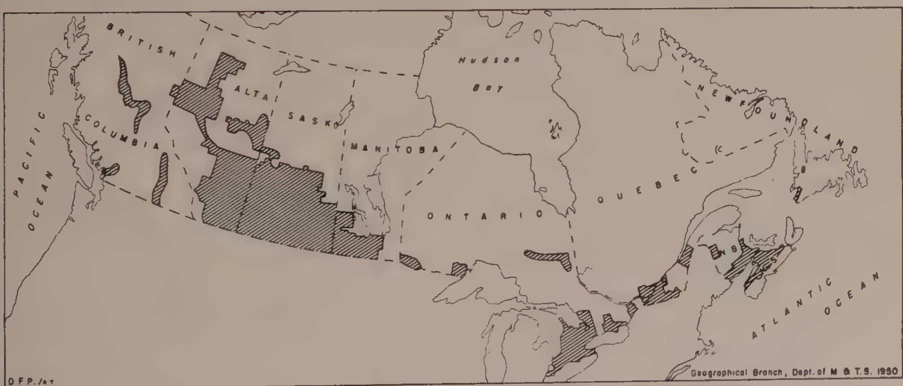

Figure 1. The areas in Canada in which soil surveys have been conducted. Note the extent of coverage in the Prairie Provinces and the patchy areas in other parts of the country. No differentiation is made here between detailed and reconnaissance surveys. (After Stobbe.)

THE SOIL ZONES OF CANADA

Any effort at draughting a soil map of Canada in the present state of our knowledge must be regarded as merely tentative. From time to time maps have appeared showing soil zones of certain provinces and one or

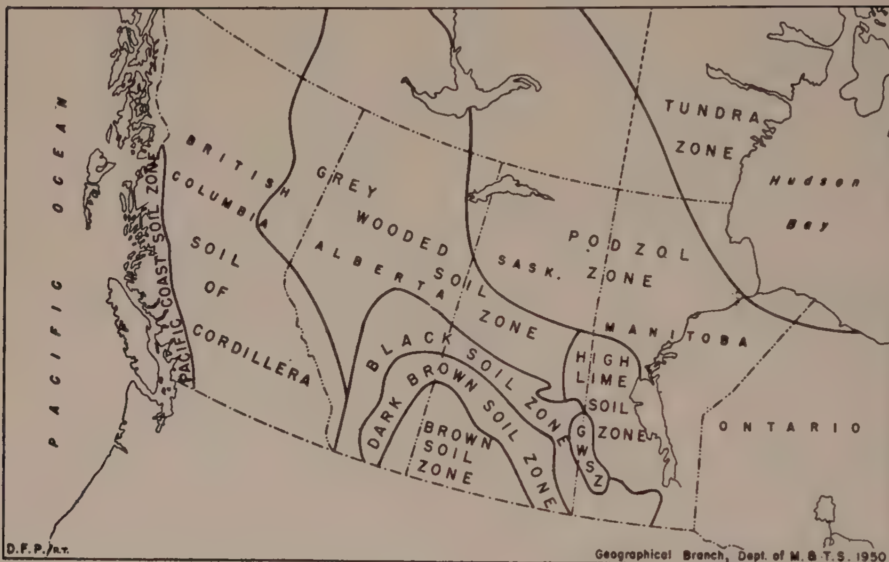

Figure 2. Generalized map of the soil zones in Western Canada. (After Leahey.)

Figure 3. Generalized map of the extent of the various soil zones in Eastern Canada. (After Leahey.)

two of the whole country have been published. The latest of these, but on a very generalized scale, is that accompanying an article by A. Leahey[1]. From this article and from soil maps of Alberta[2] and Saskatchewan[3], the work of Ellis in Manitoba[4], the work of Hills in Ontario[5], and of Rousseau in Quebec[6], together with additional data from other sources, the accompanying map of soil zones has been drawn up. For convenience it is presented in two parts, eastern, including Ontario, Quebec, the Maritime Provinces, and Newfoundland, and western, including the Prairie Provinces and British Columbia (Figures 2 and 3).

Western Soil Zones

The Brown Soil Zone

The Brown Soil zone, as mapped by Canadian pedologists, is found in the southwestern part of Saskatchewan and the southeastern part of Alberta. The Brown Soils are also found in many of the valleys in the interior of British Columbia.

The Brown Soils are found in the driest part of the treeless prairie, the region that both Palliser and Macoun[7] agreed was too dry for agricultural settlement. Leahey[8] estimates the area of this zone at 32,500,000 acres, of which about 25 per cent is arable land.

The soil survey of Saskatchewan[9] reports the following characteristic species from the shortgrass region: June grass *(Koeleria cristata)*, blue grama grass *(Bouteloua gracilis)*, common spear grass *(Stipa comata)*, western wheat grass *(Agropyron smithii)*, Sandberg's blue grass *(Poa secunda)*, nigger wool *(Carex filifolia)*, pasture sage *(Artemesia cana)*, and prickly pear cactus *(Opuntia polyacantha)*. As well as being short, such vegetation is sparse, with considerable bare soil to be seen between plants. The root systems, however, invade practically the whole soil mass in their search for available water.

Brown Soils and the associated characteristic shortgrass vegetation have developed under the most arid climatic conditions in Canada. Summer temperatures are not extreme, for only in a few interior valleys of southern British Columbia does the July mean reach 70°F., nevertheless, they are high enough to require much more rainfall than is usually received. The Brown Soil region of the Prairie Provinces gets 12 to 13 inches of rainfall a year, with a pronounced summer concentration. The dry valleys of

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1 Leahey, A.: The Agricultural Soil Resources of Canada; Agricultural Institute Review, vol. 1, pp. 285-289 (1946).

2 Wyatt, F. A., *et al.*: Wooded Soils and Their Management; Univ. of Alberta, College of Agriculture, Edmonton, Bull. 21, Pl. 1.

3 Mitchell, J., *et al.*: Soil Survey of Southern Saskatchewan; Univ. of Saskatchewan, College of Agriculture, Soil Survey Report No. 12, VIII—259 pp. maps. Saskatoon, 1944.

4 Ellis, J. H.: The Soils of Manitoba; Econ. Surv. Board of Manitoba, Winnipeg, 1938, 112 pp., illus., maps.

5 Hills, G. A.: Pedology, the Dirt Science and Agricultural Settlement in Ontario; Can. Geog. Jour., vol. 24, No. 3, pp. 106-127.

6 Rousseau, L. Z.: La classification des terres; Actualité Economique, April 1938.

7 Mackintosh, W. A.: op. cit.

8 Leahey, A.: op. cit.

9 Mitchell, J., *et al.*: op. cit., p. 256.

British Columbia have a more uniform distribution, but a yearly total that at some stations is below 10 inches.[1] Crude data such as these, however, tell only part of the story. Recently C. W. Thornthwaite has devised a means of calculating water need, which shows considerable promise.[2] Mrs. M. Sanderson has applied his techniques to Western Canada.[3]

Stations in the Brown Soil zone have a total water need of 20 to 24 inches; consequently, the deficiency may be as much as 11 inches and the average period of deficiency last from mid-June to the end of October. The accompanying diagram (Figure 4) is based upon the data for Medicine Hat, which is generally acknowledged as the centre of the dry belt. Incidentally, it is noteworthy that the theoretical border between the Semiarid and Dry Subhumid climatic types of the new Thornthwaite system corresponds very closely to the boundary of the Brown Soil zone in the Prairie Provinces.

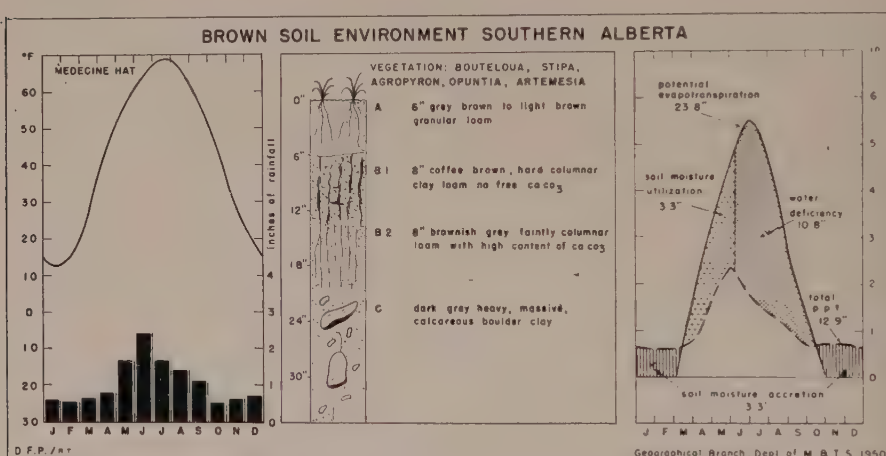

Figure 4. The climate of the Brown Soil zone may be regarded as the driest in Canada. The Thornthwaite diagram indicates that, on the average, the soil is always capable of taking on more moisture and a moisture deficiency almost equal to the rainfall exists. These conditions are reflected in the vegetation, the shallowness of the soil profile, and the intensity and position of the accumulation of carbonates.

Soil Characteristics. The accompanying diagram (Figure 4) gives a generalized version of a Brown Soil profile, developed upon glacial till. The following description is that given by Mitchell *et al.*[4] for the dominant, hard, columnar profile in the Haverhill Association that occupies more than 40 per cent, or 8,500,000 acres, of the Brown Soil zone of southwestern Saskatchewan.

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[1] Canada, Dept. of Transport, Meteorological Division: Climatic Summaries for Selected Meteorological Stations in Canada. Ottawa, *c.* 1947.

[2] Thornthwaite, C. W.: An Approach Toward a National Classification of Climate; Geog. Review, vol. 38, No. 1, pp. 55-94 (January 1948).

[3] Sanderson, M.: Drought in the Canadian Northwest; Geog. Review, vol. 38, No. 2, pp. 289-299 (April 1948).

See also: The Climates of Canada according to the new Thornthwaite Classification; Scientific Agriculture, vol. 28, No. 22, pp. 501-517 (1948).

[4] Mitchell J., *et al.:* op. cit., p. 55.

A Horizon. Grey-brown to light brown colour; moderately hard, cloddy to granular structure; 3 to 6 inches thick.

B_1 Horizon. Bright brown to darker (coffee) brown colour, frequently grading to yellow-brown or greyish brown at the bottom; hard columnar structure heavier in texture than the A horizon, and containing no free lime carbonate ($CaCO_3$); 6 to 12 inches thick.

B_2 Horizon. Brownish grey to grey colour; faint columnar structure, breaking easily into fine granular aggregates; high content of lime carbonate; 6 to 12 inches thick.

C Horizon or Parent Material. Dark grey, heavy boulder clay with massive to faintly laminated structure; at lower depths bluish grey colours occur, together with streaks and concretions of lime carbonate and gypsum, and rusty coloured specks of iron oxide. This horizon is calcareous (contains free lime carbonate), but is usually less limy than the B_2 horizon above. Glacial stones are common throughout the profile.

In general, the Brown Soils have the shallowest profiles of the grassland soils. The horizon of lime accumulation, and often of other salts as well, is closer to the surface and the concentrations of these substances are greater. The surface soil is light in colour, sometimes almost grey rather than brown, and the content of organic matter is low. When cultivated, the organic matter is rapidly exhausted and soil drifting takes place. During the dry years of the 1930s, it was the Brown Soil zone that earned the title of the Dustbowl of Western Canada. Naturally the sandy soils and lighter textured loams are more rapidly susceptible to blowing than are the heavier soils. Water erosion is also an important problem in the areas of greater relief.

Brown Soils are of a reasonably high degree of natural fertility, and when enough rain falls they produce wheat of the highest quality. It is in this region that large irrigation projects are under way in both Alberta and Saskatchewan. In spite of the recurrent temptation to plow it up in periods of high wheat prices, much the larger area in this zone should be left in grass, as it furnishes excellent pasture when properly managed.

The Dark Brown Soil Zone

The Dark Brown Soils are also found under open grasslands, but with better moisture conditions and a heavier cover of vegetation. They occupy an area of about 35,000,000 acres[1], in the form of a belt 50 to 100 miles in width surrounding the region of Brown Soils. Of this, about 18,500,000 acres are in Saskatchewan and the remainder in Alberta. This belt was also included within the confines of Palliser's triangle. To the casual observer there seems little difference in the landscape qualities of the two zones, and certainly there is no sharply demarcated boundary. It is, therefore, not surprising that even pedologists are inclined to shift the boundary from time to time.

For purposes of comparison we may let Regina represent the Dark Brown Soil zone, as we did Medicine Hat in the Brown Soil zone (Figure 5). The average rainfall is 14·7 inches with 10·5 inches coming in the 5 warm months, May to September. Regina summer temperatures are 3 to 5

[1] Leahey, A.: op. cit.

degrees lower, hence the total water need is only about 21 inches and the moisture deficit about 6½ inches, occurring from the middle of July to the middle of September. Winter precipitation at Regina is actually slightly less than at Medicine Hat and hence moisture storage in the soil is less (Figure 5).

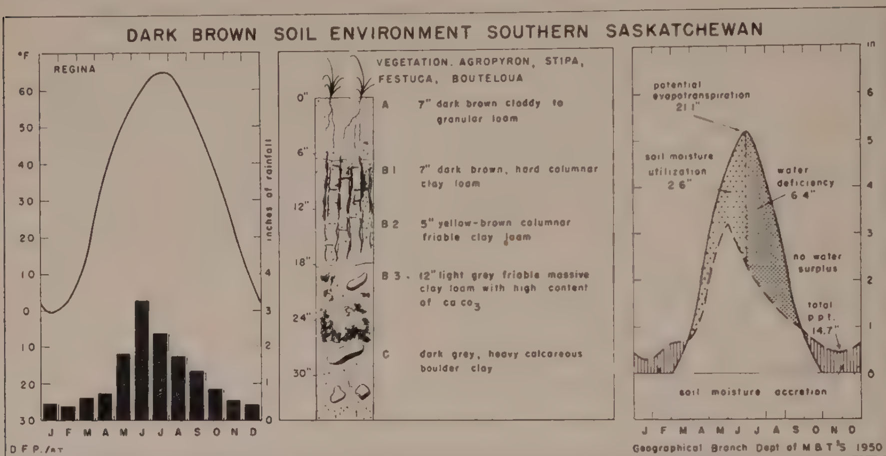

Figure 5. As in the Brown Soils the Dark Brown Soil may also not become fully recharged with water during the cool seasons; however, the more ample summer rainfall promotes a ranker vegetation, and hence a darker and deeper soil profile.

The vegetation includes the same "short grasses" mentioned previously, together with taller ones such as northern wheat grass *(Agropyron dasystachyum)*, green spear grass *(Stipa viridula)*, rough fescue *(Festuca scabrella)*, and side-oats grama grass *(Bouteloua curtipendula)*. In a few places where moisture conditions are more favourable, small groves of poplar, willow, and various shrubs may occur.

Soil Characteristics. There is little to distinguish the soils of this belt from those of the drier area except the darker brown colour, due to the greater accumulation of organic matter in the surface horizon, and a slightly greater depth of the profile. The horizon of lime accumulation may begin at a foot to 18 inches below the surface.

The Weyburn association covers more than 7,750,000 acres, being the most widespread of the Dark Brown Soils associations in Saskatchewan. There are also large areas in Alberta that may be correlated.

The description of the normal profile follows:

A Horizon. Dark brown, hard cloddy structure, breaking to granular aggregates. Somewhat darker colour at the surface and softer cloddy-granular structure in more moist sections of the dark brown zone (4 to 7 inches thick).

B_1 Horizon. Heavier textured, rusty brown to dark brown; hard columnar structure; the columns are of medium to large size and often break into flat-topped segments, and under pressure to coarse granules (6 to 8 inches thick).

B_2 Horizon. Yellow-brown; columnar structure, but more friable than B (2 to 6 inches thick). In shallow profiles this horizon may not be well developed and the B_1 horizon may rest directly upon the lime carbonate layer.

B_3 Horizon. (B_2 in the shallower profiles.) Light greyish colour; friable massive structure, breaking easily into granules; high content of lime carbonate (6 to 12 inches or more in thickness).

C Horizon. Dark grey, sandy clay to clay; massive to faintly laminated structure. This horizon is marked by spots and concretions of yellowish, rusty, and blue-grey material, with light greyish streaks of lime carbonate and salts. Glacial stones, small stone fragments, and gravel are common. Some slight sorting is evident in undulating (ground-moraine) areas, as is shown by laminate structure water-worn glacial pebbles and more uniform texture.[1]

Along the zone boundary there are mixed areas of Weyburn and Haverhill soils, the Brown Soil occupying the drier sites whereas the Dark Brown profile is found in slightly moister areas.

The agricultural resources of the Dark Brown Soil zone are much greater than those of the Brown Soil zone. The organic matter content, fertility, moisture holding capacity, and, consequently, productivity, of these soils are much greater. Over 60 per cent (21,000,000 acres) of this zone is classed as arable land.[2] The chief crop is wheat and this belt is recognized as the one in which the most reliable high quality is to be found. The natural hazards of the region are much less than those of the Brown Soil zone, although greater than those of the Black Soil belt. Although most of the cultivatable land in this zone is already in use, there is estimated to be still about 2,000,000 acres, chiefly in Alberta, of potential crop land.

The Black Soil Zone

Between the open prairies and the forest in the Prairie Provinces lies a zone of Black Soils, estimated to cover about 42,000,000 acres. They have developed under a luxurious covering of tall grasses and flowering plants. Interspersed here and there are small "bluffs" or clumps of trees, indicative of an increasing moisture supply. This mixture of grass and trees is often termed a "Park" landscape.

Some of the important grasses in this zone are: awned wheat grass *(Agropyron subsecundum)*, slender wheat grass *(A. pauciflorum)*, northern wheat grass *(A. dasystachyum)*, fringed brome grass *(Bromus ciliatus)*, marsh reedgrass *(Calamagrostis canadensis)*, northern reedgrass *(C. inexpansa)*, Hooker's oatgrass *(Avena Hookerii)*, and June grass *(Koeleria cristata)*. There are numerous forbs or flowering plants, including: Plains cinquefoil *(Potentilla bipinnatifida)*, hairy cinquefoil *(P. strigosa)*, anemone *(Anemone canadensis)*, crocus *(Pulsatilla ludoviciana)*, milk vetch *(Astragalus goniatus)*, baneberry *(Actea rubra* and *A. alba)*, sweet pea *(Lathyrus ochroleucus* and *L. venosus)*, and golden pea *(Theomopsis rhombifolia)*. The woody vegetation is made up of: aspen *(Populus tremuloides)*, black poplar *(P. tacamahaca)*, Saskatoon bush *(Amelanchier alnifolia)*, highbush cranberry *(Viburnum trilobum)*, dogwood *(Svida instolonea)*, willows *(Salix discolor, S. Bebbiana,* and *S. petiolaris)*, and, in the southeastern section, Bur oak *(Quercus macrocarpa)*, Manitoba maple *(Acer Negundo)*, elm *(Ulmus americana)*, and green ash *(Fraxinus campestris)*.

[1] Mitchell, J., *et al.*: op. cit.
[2] Leahey, A.: op. cit.

Being for the most part somewhat farther north the stations in the Black Soil zone have lower temperatures, particularly in the winter. Winnipeg in the southern part of the zone is almost as cold in January (−3°F.) as Prince Albert or Lloydminster (−4°F.) in the north. In midsummer, however, Winnipeg is about 4 degrees warmer (July 63° and 67°F.). Rainfall varies from 15 to more than 20 inches a year, with most of it in the summer. Although, all told, there is more climatic variation in this belt than in either of the others, we may use the figures for Winnipeg (Figure 6). Applying the Thornthwaite formulæ, we find that the evapotranspiration, or water need, is 22·4 inches, and as the annual precipitation is 21·2 inches, the overall deficit is 1·2 inches. It is actually somewhat greater, however, for the heavier snowfall in the winter months provides a slight amount of runoff, a condition not found, theoretically, in the climates of the other grassland zones.

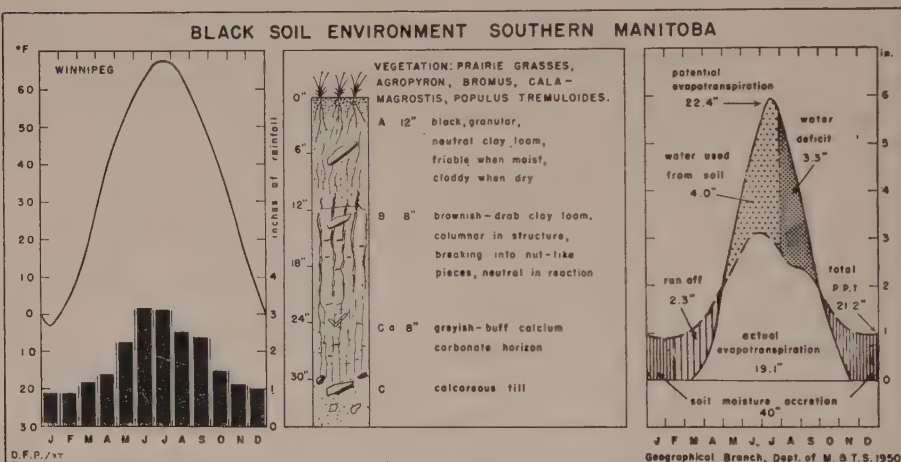

Figure 6. The climate of Winnipeg may be taken to represent that of the Black Soil zone of southern Manitoba. The total rainfall is 21·2 inches but as 2·3 inches escapes as spring runoff, the deficit amounts to 3·3 inches. Stations farther north and west in this soil zone have less rainfall, and even with slightly lower summer temperatures, have slightly greater water deficits.

Soil Characteristics. The Black Soils are distinguished from the other grassland soils by the darker colour and higher organic matter content of the surface soil and by a somewhat deeper development of the soil profile. They are, of course, formed on many different sorts of parent material, but in order to facilitate comparison reference will be made to the Oxbow Association. This group of soils is, as was the case with the Haverhill and Weyburn, developed upon "undifferentiated glacial till". The Oxbow Association is the most extensive group of Black Soils, covering an area of 6,750,000 acres in Saskatchewan and a large area of southwestern Manitoba as well. Certain areas in Alberta, too, though not named, must certainly be correlated with the Oxbow soils identified just to the east of them.

The generalized description of the dominant hard columnar profile of the Oxbow Association in Saskatchewan follows[1]:

A_1 Horizon. Very dark brown, brown to nearly black, friable, granular and soft-cloddy structure at surface, cloddy below (4 to 7 inches thick). The dark surface colour gradually fades with depth, and in the deeper Oxbow profiles a dark greyish brown A_2 horizon may be distinguished.

B_1 Horizon. Reddish brown to dark brown; moderately hard columnar structure, but with the columns less well defined than in Weyburn and Haverhill soils (6 to 10 inches thick). The bottom of the B_1 horizon may be yellowish brown or greyish brown in colour; forming a transition to the lower B where this transitional layer is well developed it may be regarded as a B_2 horizon.

B_2 Horizon. (B_3 if above separation be made.) Light grey to brownish grey; massive structure, but very friable, falling easily into fine granules. High content of lime carbonate (8 to 18 inches or more thick).

C Horizon. Dark grey to medium grey, calcareous (limy) boulder clay; this deposit is marked by spots and concretions of yellowish, rusty, and bluish grey material and by light greyish streaks of lime carbonate and salts; glacial stones, small stone fragments, and gravel are common. Some slight sorting is evident in many undulating (ground moraine) areas, as shown by the faintly laminated structure and water-worn glacial pebbles.

Black Soils as a group show more variation in profile types than the other grassland soil groups. Some associations such as the Yorkton, Naicam, and Melfort have surface soils that may be 12 to 15 inches or more deep.

On the other hand, many "Shallow Black" profiles are described that have surface soils less than 4 inches thick.

The Black Soils are regarded as being naturally the most fertile agricultural soils in Canada. About 30,000,000 acres are classified as arable and probably at least 90 per cent of this area is now in use. Although the yields of wheat in this belt are always greater and more reliable than in the other grassland belts, nevertheless farming in this area shows more diversification. Other grains and forage crops are grown as the basis of a livestock economy and farm incomes may be more largely derived from the sale of hogs and dairy products. The excellence of these soils is shown by the fact that whereas the average size of a farm in the Dark Brown Soil zone is about 1 square mile, and in the Brown Soil zone about 1,000 acres, most of the farms in the Black Soil zone have an area of about 320 acres.

Intrazonal and Transitional Soils of the Grassland Soil Zones

In the foregoing discussions little mention has been made of the fact that in addition to the dominant or normal member of the soil association various other member profiles occur. In the subhumid and semi-arid regions of Canada—as in all the grassland regions of the world—most of these intrazonal types are conditioned by impeded drainage and concentration of salts in the soil. Naturally enough, many of the areas thus affected are low lying and of little relief. There the regular succession of saline and alkaline soils might be expected to occur. Other areas, even though of moderate relief, are influenced by parent material. The bedrock

[1] Mitchell, J., *et al.:* op. cit., p. 105.

of the Prairie Provinces throughout large areas is composed of Cretaceous marine shales, some members of which contain high concentrations of salts. Residual soils and those developed on tills derived from these salty rocks are, therefore, likely to be strongly influenced. Many solonetzic profiles have, accordingly, been described in areas having a fair amount of relief.

In other areas parent materials have been derived from limestones, and the development of the soil profile has been impeded by the high content of calcium carbonate. Thus some associations on the Canadian Prairies have rendzina or rendzina-like member profiles. Some of the so-called "Shallow Black" soils seem to belong to this group.

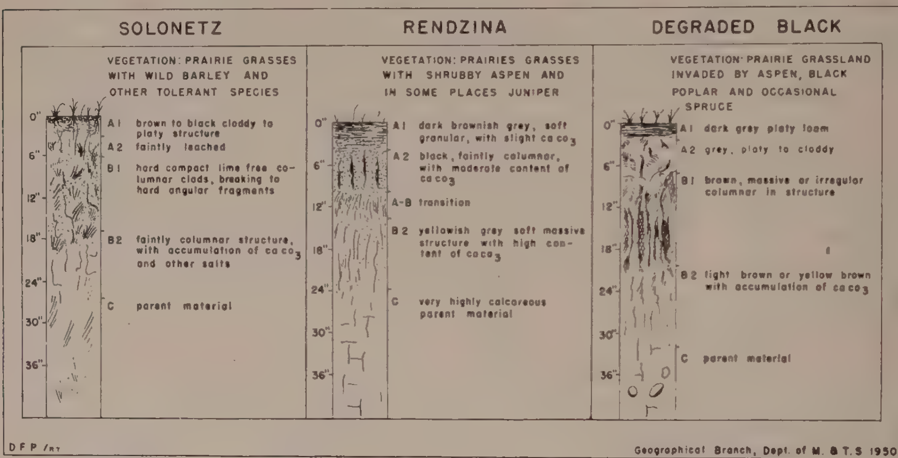

Figure 7. Profile diagrams of three commonly found grassland intrazonal soils of the Prairie Provinces. (Adapted from Mitchell *et al.*)

The humid margins of the Black Soil zone are marked by transitional soils developed where the forest has succeeded in invading the grasslands. These soils, in which the lower horizons still retain the evidence of their grassland origin, have leached or degraded A horizons and are known as Degraded Black Soils. In Saskatchewan about 3,000,000 acres are thus classified, and large areas are found in Manitoba and Alberta also. In agricultural value they rank about midway between the Black Soils and the Grey Wooded Soils of the adjoining forest regions (Figure 7).

The Grey Wooded Soil Zone

As defined by Leahey[1], the Grey Wooded Soil zone covers about 150,000,000 acres lying between the Rocky Mountains and the Canadian Shield in Western Canada. Grey Wooded Soils have been identified, also, in the intermontaine region of British Columbia.[2] Though very large, this

[1] Leahey, A.: op. cit., p. 287.

[2] Kelly, C. C., and Farstad, L.: Soil Survey of the Prince George Area; Canada, Department of Agriculture, Ottawa, 1946, 58 pp., maps.

zone appears to have a rather low percentage of arable land and much of the best of it is already used for pioneer agriculture. Nevertheless, it is estimated that eventually a total of 20,000,000 to 25,000,000 acres may be farmed.

The climate of this zone is colder in winter and cooler in summer than the adjoining Black Soil zone. At its southern margin the mean annual rainfall is about 15 inches. Northward, however, the rainfall and temperature both decrease so that the area of Thornthwaite's Dry Subhumid Climatic Type is extended all the way to the Arctic Sea[1]. Water needs decrease northward, with temperature, from 19 to 13 inches, but moisture deficits are maintained at 3 to 5 inches and the spring surplus resulting from winter snow is uniformly about 1 inch. Except for temperature relationships, then, climatic conditions in this zone are not far removed from those of the grassland regions. Indeed, this is self evident from the fact that large areas of grassland and transitional soils are found in the Peace River district, far to the northwest of the main grassland zones.[2-4]

The best description of the woodland vegetation of this belt is that given by E. W. Tisdale.[5] He outlines three forest associations. The first, designated as "Normal Poplar", is characterized by fairly dense stands of aspen *(Populus tremuloides)*, in which distinct age classes, usually in separate areas, may be recognized. Spruce is scanty and represented by a few small trees and seedlings. The underbrush consists of hazel *(Corylus rostrata)*, cranberry *(Viburnum eradiatum)*, and rose *(Rosa aciculans)*. The ground cover is composed of twinflower *(Linnaea americana)*, dewberry *(Rubus pubescens)*, sarsaparilla *(Aralia* sp.), diasporum *(Diasporum trachycarpum)*, and coltsfoot *(Petasites palmatus)*. Mosses are not abundant.

The second or "Open Poplar" association is confined to sandy and gravelly soils. The poplars are wide spaced, shorter, and more branching. Willows *(Salix Bebbiana)* are present, but no spruce. Rose, blueberry *(Cyanococcus canadensis)*, bearberry *(Arctostaphylus Uva-ursi)*, wild rye *(Elymus innovatus)*, and other grasses constitute the under cover. The third and probable climax forest is the "Poplar-Spruce" association, which develops where the spruce *(Picea glauca)* has had protection from fire. Cranberry and buffalo-berry *(Shepardia* sp.) are the principal shrubs, and mosses and lichens are common.

Poplar and spruce are also the chief trees mentioned in the wooded districts west of Edmonton.[6] The forests on the Grey Wooded Soils of British Columbia are composed of aspen, birch *(Betula papyrifera)*, lodgepole pine *(Pinus contorta)*, white spruce, and sub-alpine fir *(Abies lasiocarpa)*.[7]

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[1] Sanderson, M.: op. cit., p. 298.

[2] Wyatt, F. A., and Younge, O. R.: Preliminary Soil Survey Adjacent to the Peace River, Alberta, West of Dunvegan; Research Council of Alberta, Report No. 23, 1930.

[3] Mackintosh, W. A.: op. cit., Chapter 8.

[4] Wyatt, F. A.: Preliminary Soil Survey of the Peace River-High Prairie-Sturgeon Lake Area; Research Council of Alberta, Report No. 31, 1935.

[5] Tisdale, E. W., *in* Rawson, D. S., *et al.:* The Big River Survey; Univ. of Saskatchewan, Saskatoon, 1943.

[6] Wyatt, F. A., *et al.:* Soil Survey of St. Ann Sheet; Univ. of Alberta, College of Agriculture, Bull. No. 20, 1930, p. 19.

[7] Kelly, C. C., and Farstad, L.: op. cit., p. 19.

Soil Characteristics. The reason for considering these soils as a separate group, apart from the Podzols, is that although they have a leached A_2 horizon, they are, in general, not very acid, and they have a strong tendency to accumulate calcium carbonate at the base of the profile (Figure 8). It would seem from the climatic evidence that they are adjusted to their environment and should be regarded as zonal soils.

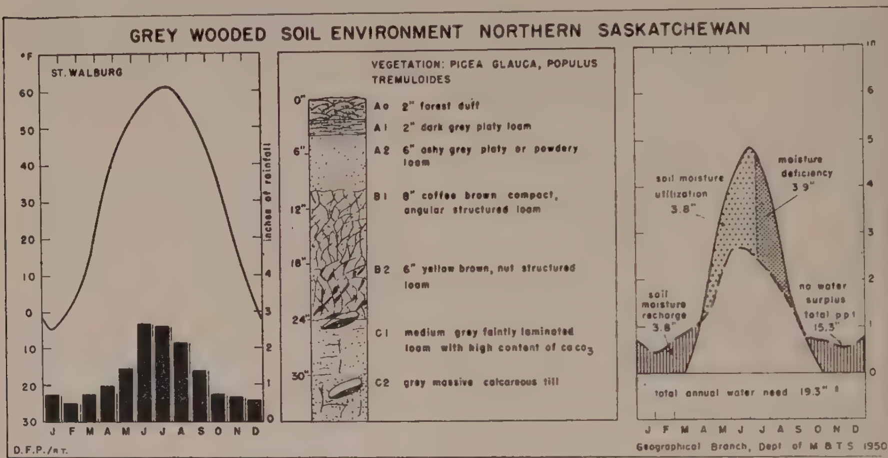

Figure 8. The Grey Wooded environment produces a forest cover and a partly leached A horizon, but there is normally no water surplus in the cool season and the summer climate is as dry as that of the Black Soil zone. Under such conditions an horizon of lime accumulation is formed at the base of the soil profile.

An important association, which covers an area of over 1,700,000 acres in Saskatchewan, is the Waiteville, which is found on a parent material of glacial till. The profile of the dominant soil member is described as follows[1]:

A_0 Horizon.	Raw and partly decomposed organic matter such as leaves and other plant residues (1 inch to 4 inches thick). This horizon is frequently absent where forest fires have occurred or where burning is practised prior to clearing and breaking.
A_1 Horizon.	Dark grey to dark brown, faint platy structure (0 inch to 2 inches thick).
A_2 Horizon.	Light (ashy) grey; platy structure but falling easily to powdery or loose structureless condition (4 to 10 inches thick).
B_1 Horizon.	Dark ("coffee") brown to greyish brown; heavy, compact, frequently massive structure but breaking to hard angular fragments (6 to 10 inches thick).
B_2 Horizon.	Lighter brown, or yellow-brown; massive structure, compact, breaking to nut-like aggregates (4 to 8 inches thick).
C_1 Horizon.	Medium grey with some brown and yellowish mottling; massive to faintly laminated structure, breaking easily to granular condition. High content of lime carbonate (12 to 24 inches thick).
C_2 Horizon.	Medium to dark grey, marked with rusty, yellowish, bluish grey and whitish streaks and spots; moderate to high lime carbonate content. Massive to faintly laminated structure. Boulders may occur throughout the profile; small stones, many of them showing evidence of disintegration through chemical weathering, are common in the B_2 and C_1 horizons.

[1] Mitchell, J., *et al.*: op. cit., p. 160.

Normal profiles described in Alberta and Manitoba show the same general features, particularly the concentration of lime at the base of the profile. Although they appear highly leached in the A horizon they are only slightly acid whereas the eastern podzols are quite acid. They are, however, considerably lower in natural fertility than the adjoining grassland soils.

Mixed farming with emphasis on livestock and the growth of legumes seems to be necessary to utilize these soils advantageously as they do not produce high quality wheat. In some parts of Saskatchewan success has been experienced in the growth of alfalfa seed.

The High Lime Soil Zone

This area lies between Lake Winnipeg and Lake Manitoba and to the west and north of the latter. The climate and vegetation are those of the Grey Wooded Soil zone, but the highly calcareous material, derived from Palæozoic limestones, has inhibited the development of the normal profile. The surface soils may be highly alkaline and contain traces of unleached calcium carbonates. The profile is always shallow and poorly differentiated. Ellis[1] refers to them as Rendzinas, although the true Rendzina is a grassland soil and, indeed, probably representatives of the intrazonal group are to be found on the Canadian Prairies.[2] They are really to be regarded as forested counterparts of the Rendzinas or as degraded Rendzinas.

Such soils are to be found in many parts of the world. They are common in southern Ontario[3] where they have developed upon highly calcareous glacial till and upon varved clays composed largely of freshly ground limestone rock flour. They have been reported in France[4] where they seem to have developed when soils originally under grass have been overgrown by forest on account of post-glacial climatic changes.

The case of climatic change may very well apply in the high lime zone of Manitoba. Most of this zone is not suitable for agriculture as the soils are shallow, rocky, and coarse textured. At one time a considerable number of settlers entered the region, but later there was wholesale abandonment of occupied lands.

The Soils of the Cordilleran Region

This region, which includes the greater part of the province of British Columbia and the territory of Yukon, is much too varied to be shown on a small scale map. It is, moreover, very imperfectly known.

One soil survey report has recently been issued for the southern interior of British Columbia.[5] The area described extends northward from the International Boundary for 140 miles along the Okanagan Valley. In this

[1] Ellis, J. H.: op. cit., p. 57.

[2] Mitchell, J.: op. cit., p. 114.

[3] Chapman, L. J., and Putnam, D. F.: The Soils of South-central Ontario; Scientific Agriculture, vol. 18, pp. 161-197 (1938).

[4] Agafonoff, V.: Les sols de France au point de vue pédologique; Soil Research, vol. 4, pp. 363-379 (1935).

[5] Kelly, C. C., and Spilsbury, R. H.: Soil Survey of the Okanagan and Similkameen Valleys, British Columbia; B.C. Dept. of Agriculture in co-operation with Experimental Farms Service, Dominion Department of Agriculture, 1949.

distance there is complete gradation from a very dry climate, sparse grassland, and brown soils in the south, through zones of dark brown and black soils to forests and podzols in the north. The agriculture changes also from intensive horticulture under irrigation to general farm crops and dairying without irrigation. The valley sides very clearly exhibit a vertical succession of soil zones, as illustrated in Figure 9.

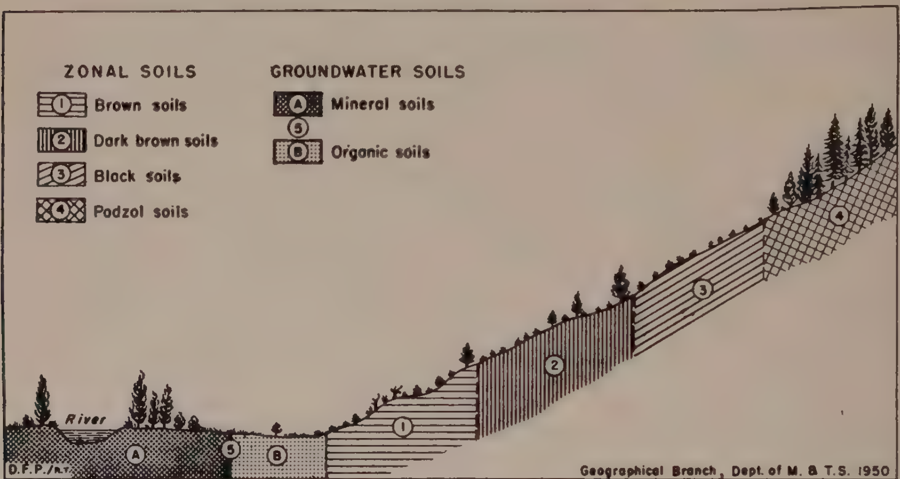

Figure 9. The vertical positions of the five soil groups in the Okanagan Valley. (After Kelly and Spilsbury.)

Another discussion of vertical zonation of great soil groups is given by Spilsbury and Tisdale[1] for the Thompson Valley near Kamloops.

Conditions in the central part of British Columbia are represented by the Prince George area[2], where a block about 700,000 acres in extent has been surveyed. Here the soils have been classified in the Grey Wooded group.

Along the mountain sides soil zones are arranged vertically and a regular sequence from brown soils to podzols and alpine tundra may be found.

Relatively little of this region is used for agriculture. In the southern valleys, areas of brown soils have been brought under cultivation and through the use of irrigation have become very productive orchard lands. Farther north, field crops and livestock are the main farm enterprises. Leahey[3] states that in this whole vast area only about 3,000,000 acres of potentially arable land exist but there are many millions of acres of range land available for grazing.

The Soils of the Pacific Coast

Along the Pacific coast there is a narrow, and mostly mountainous, strip of land where a marine type of climate prevails. The winters are mild and wet and the summers cool and, particularly in midsummer, dry. The vegetation is a dense coniferous forest containing some very large trees.

[1] Spilsbury, R. H., and Tisdale, E. W.: Soil-plant Relationships and Vertical Zonation in the Southern Interior of British Columbia; Scientific Agriculture, vol. 24, pp. 395-436 (1944).
[2] Kelly, C. C., and Farstad, A.: op. cit.
[3] Leahey, A.: op. cit., p. 289.

Among them may be listed western red cedar *(Thuja plicata)*, western hemlock *(Tsuga heterophylla)*, and Douglas fir *(Pseudotsuga taxifolia)*, which make this area the most noted lumber producing region in Canada.

In this whole region the largest block of available agricultural land is found in the lower Fraser Valley, the soils of which have been described in a recent bulletin.[1] Here, in a total surveyed area of 545,000 acres, 368,000 acres have been classified as present or potential arable land.

The rainy climate of this region tends toward podzolization, although even the zonal soils have only a shallow leached horizon and a very weakly developed horizon of accumulation. It is possible that the period of summer drought may account for this. The soils have reddish subsoils and in this show a relationship to the soils of California and other lands of Mediterranean climatic type. On the other hand, it is suggested that many of these soils are very similar to the Brown Podzolic soils.[2] For the most part, however, the soils of greatest agricultural value are the intrazonal and azonal types of the lower parts of the Fraser Valley developed upon alluvial material under the influence of a high water-table. Even on the raised terraces, impervious strata of old alluvium have caused the formation of intrazonal soils.

The soil characteristics and economic potentialities of the Pacific coast soils are more like those of the regions of Eastern Canada than like the Prairies, yet there are significant differences and probably they should be classified in a separate great soil group.[3]

Eastern Soil Zones

The Grey Brown Podzolic Soil Zone

This is one of the smaller soil zones in Canada, being a northern outlier of the broad belt of temperate, forested lands of northeastern United States. It includes only southern Ontario and the southwestern part of the St. Lawrence Valley in Quebec (*See* Figure 3).

Climate. The climate of this region has, on the whole, slightly higher summer temperatures and a longer growing season than that of the Prairie region. Winters, also, are considerably milder and in the extreme southwest much shorter. There is more variation in winter than in summer conditions[4], but soil formation is probably more dependent upon the latter.

Toronto is chosen as representative of this region because its conditions seem to be about midway between the extremes, and because it has a set of records unbroken for over a century. As shown in the accompanying

[1] Kelly, C. C., and Spilsbury, R. H.: The Soils of the lower Fraser; Canada, Dept. of Agriculture, Pub. 650, Tech. Bull. 20, Ottawa, 1939.

[2] Lyford, J. W. H.: Morphology of the Brown Podzolic Soils of New England; Soil Science Society of Amer. Proc., vol. 2, pp. 486-492 (1947).

[3] A recent most valuable contribution to pedogeography in British Columbia from the pen of Dr. Charles A. Rowles is contained in the Transactions of the Second Resources Conference (1949), published by the B.C. Department of Lands and Forests, Parliament Buildings, Victoria, B.C. It contains descriptions of the various soil zones of the province and estimates that there is an area of 6,000,000 acres of possible potential arable land.

[4] Putnam, D. F., and Chapman, L. J.: The Climate of Southern Ontario; Scientific Agriculture, vol. 18, pp. 401-446 (1938).

diagram (Figure 10), the mean monthly temperatures range from 22°F. in January to 70°F. in July. The warmest place in Canada, Pelee Island, has a July mean of 74°F. The mean annual precipitation is 32·2 inches, almost uniformly distributed in the 12 months. About 6 inches of water is credited to winter snowfall (61·9 inches snowfall). Though uniformly distributed in time, this water supply does not balance the water need, August and September having a moisture deficit of 2·5 inches whereas winter and spring provide a runoff of nearly 11 inches.

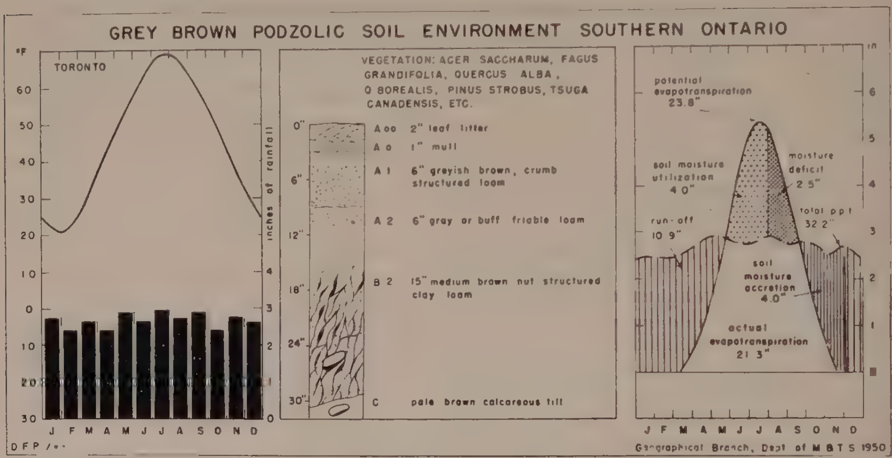

Figure 10. Grey Brown Podzolic soils normally have no accumulation of lime in the profile because of the excess of water that percolates through the soil to run off in stream drainage. The comparatively low rainfall in the summer makes this a wet and dry climate with a definite lack of soil moisture in most years. The total precipitation is ample, but too much of it comes in the winter. Spring thaws bring on rapid runoff and soil erosion.

Vegetation. The natural vegetation of the area is hardwood forest in which the climax types contain sugar maple *(Acer saccharum)*, beech *(Fagus grandifolia)*, white oak *(Quercus alba)*, red oak *(Q. borealis)*, and basswood *(Tilia glabra)*, as well as many other trees of less importance. On sites with slightly imperfect to poor drainage, the American elm *(Ulmus americana)* is the dominant tree. With it may be associated white ash *(Fraxinus americana)*, black ash *(F. nigra)*, yellow birch *(Betula lutea)*, red maple *(Acer rubrum)*, and white or silver maple *(A. saccharinum)*. White cedar *(Thuja occidentalis)* is common in swampy areas.

Soil Characteristics. Here as in the western plains the parent materials are almost all of glacial origin, and a great wealth of land forms has been described.[1-5] Drainage conditions vary greatly, and several different soil

[1] Putnam, D. F., and Chapman, L. J.: The Physiography of South-central Ontario; Scientific Agriculture, vol. 16, pp. 457-477 (1936).
[2] Chapman, L. J., and Putnam, D. F.: The Physiography of Eastern Ontario; Scientific Agriculture, vol. 20, pp. 424-444 (1940).
[3] Chapman, L. J., and Putnam, D. F.: The Physiography of Southwestern Ontario; Scientific Agriculture, vol. 24, pp. 101-125 (1943).
[4] Chapman, L. J., and Putnam, D. F.: The Moraines of Southern Ontario; Trans. Roy. Soc., Canada, sec. 4, pp. 33-41 (1943).
[5] Putnam, D. F., and Chapman, L. J.: The Drumlins of Southern Ontario; Trans. Roy. Soc., Canada, sec. 4, pp. 75-88 (1943).

profiles will be found associated on the same parent material. In the soil survey reports published to date, however, the soils have been described under taxonomic series similar to those of the United States Soil Survey.[1-4] More general accounts of two areas in southern Ontario have been written[5,6] in which the geographic unit was the "land type" based largely on land form and materials.

The underlying bedrock of this region belongs to the Lower Palæozoic systems and is largely composed of limestone and dolomite, hence most of the glacial materials are highly calcareous. In order to keep the comparison with the western profiles already quoted, the following description of a soil profile formed on calcareous till is given:

A_0 Horizon.	(0 to 1 inch.) A thin layer of litter and forest mould.
A_1 Horizon.	(4 to 6 inches.) Dark greyish brown loam with friable crumb structure, few stones, neutral; pH 7·0.
A_2 Horizon.	(8 to 12 inches.) Greyish brown loam or sandy loam; weak platy structure. pH 6·8.
A_3 Horizon.	(0 inch to 2 inches.) Brownish grey loam, slightly compacted; pH 7·0.
B Horizon.	(2 to 4 inches.) Brown loam, weak blocky structure; pH 7·2.
C Horizon.	A grey, calcareous till dominated by limestone materials and containing fragments from Precambrian rocks; frequent stones and boulders. A zone of partial oxidation may extend 6 to 10 feet in depth; pH 8·0.

In other till areas where there is a larger admixture of clay derived from shaly beds, the B horizons are deeper (12 to 16 inches) and have a much more highly developed blocky structure. They are also somewhat more acid.

Except for those formed upon very light sandy materials the zonal grey-brown soils are all of moderate fertility and are productive under a mixed crop and livestock economy. The sandy soils, formed on terrace and deltaic materials, were rather non-productive under the early extensive field crop agriculture and many areas were abandoned. Such areas are now being sought out for specialized agriculture, in particular the production of flue-cured tobacco.

Some of the most productive areas, however, are those having intrazonal soils formed under conditions of imperfect drainage. These have deep dark surface soils, high in organic matter and unleached of their inorganic fertility. When artificially drained they are used for both extensive and intensive types of agriculture. Leahey[7] estimates this zone to include an area of 25,000,000 acres, more than 60 per cent of which is classed as improved land. It is doubtful if the available virgin land will

[1] Cann, D. B., and Lajoie, P.: Soil Survey of Stanstead, Richmond, Sherbrooke, and Compton Counties in the Province of Quebec; Canada, Dept. of Agriculture, Pub. 472, Tech. Bull. 45, Ottawa, 1942.

[2] Hills, G. A., *et al.*: Soil Survey of Carleton County, Province of Ontario; Ontario Soil Surv., Rept. No. 7, Guelph, 1946, 103 pp., maps.

[3] Webber, L. R., *et al.*: Soil Survey of Durham County; Ontario Soil Surv., Rept. No. 9, Guelph, 1946, 68 pp., map.

[4] Cann, D. B., *et al.*: Soil Survey of Shefford, Brome, and Missisquoi Counties in the Province of Quebec; Canada, Dept. of Agriculture, Experimental Farms Service, Ottawa, 1947.

[5] Chapman, L. J., and Putnam, D. F.: op. cit., pp. 161-197 (1938).

[6] Chapman, L. J., and Putnam, D. F.: The Soils of Eastern Ontario; Scientific Agriculture, vol. 22 ,pp. 608-636 (1942).

[7] Leahey, A.: op. cit., p. 287.

any more than offset the area that should be retired from cultivation. It is to be expected, however, that as population and economic pressures increase a greater variety of crops and higher production will be obtained from the Grey Brown Podzolic soils.

Brown Podzolic Soil Zone

The Brown Podzolic Soils are, for the most part, found along the northern margin of the Grey Brown Podzolic Soil zone and are to be regarded as a transition from them toward the true Podzols. As demarcated in Figure 3, it comprises the southern fringe of the Canadian Shield in both Ontario and Quebec and, in the latter province, a considerable part of the Appalachian uplands as well. Extending as it does from the border of Manitoba to the boundary of the State of Maine, it embraces an area of over 100,000,000 acres, but only a very small part can be regarded as potentially of agricultural value. In fact only a small part of the zone has zonal Brown Podzolic Soils. According to Hills[1], much of it is occupied by dry, intrazonal podzols.

The climate of this belt is, on the whole, cooler in summer, distinctly colder in winter, and has slightly less rainfall than the Grey Brown Podzolic Soil zone. Moreover, more of the precipitation comes as winter snowfall.

The natural vegetation of the zone was a mixed forest of hardwood and conifers. White pine *(Pinus strobus)* reached its greatest development in this area. Other trees include sugar maple *(Acer saccharum)*, yellow birch *(Betula lutea)*, hemlock *(Tsuga canadensis)*, red pine *(Pinus resinosa)*, and white spruce *(Picea glauca)*.

An example of a Brown Podzolic Soil profile, Galesburg loam, is described by Hills[2] *et al.* as follows:

A_0 Horizon.	(1 inch.) Mat of partly decomposed leaf litter.
A_1 Horizon.	(2 inches.) Dark grey-brown, sandy loam; pH 6·4.
A_2 Horizon.	($\frac{1}{4}$ to 1 inch.) Grey, leached, sandy loam; pH 5·8.
B_2 Horizon.	(6 inches.) Moderately dark yellow-brown, sandy loam, little compaction; pH 6·0.
B_3 Horizon.	(6 inches.) Light yellow-brown, sandy loam; pH 6·4.
C Horizon.	Yellow-brown, sandy loam; carbonate content very low; pH 6·8.

"As indicated above, the Brown Podzolic Soils have a fairly definite A_1 horizon, but this is generally more fibrous and less crumbly than that commonly found in the Grey Brown Podzolics. The A_2 horizon is shallow and resembles that of the podzols. The underlying layer, shown as the B horizon, has not the compact structure common to the Grey Brown Podzolic Soil. Neither is the boundary as consistently distinct between the B and the slightly weathered (oxidized) parent materials underlying it."

The climatic, vegetational, and soil relationships of this zone are illustrated in Figure 11.

[1] Hills, G. A.: op. cit., p. 108.
[2] Hills, G. A., *et al.*: op. cit., p. 31.

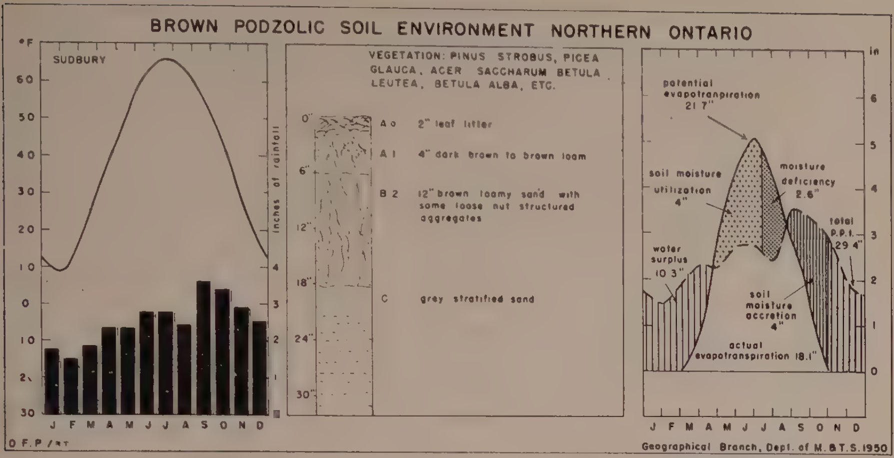

Figure 11. Environment of Sudbury in the Brown Podzolic Soil zone. The chief difference from the zone to the south is in lower temperatures and hence lower evapotranspiration.

Such soils, of course, are not highly valued for agriculture; nevertheless considerable acreages are farmed, in some cases successfully. It is not expected that much increase in farm land will take place here; rather, much of that now occupied will be abandoned to the growth of timber, for which it is more suitable. Agriculture will maintain itself, however, in many pocket areas of clay soils such as those in the Lake Nipissing lowland.

The Eastern Podzol Soil Zone

The Podzol Soil zone is the largest in Canada. Its exact size and boundaries are yet unknown, but pedologists are quite familiar with the soils of its southern part in the Maritimes, Newfoundland, Quebec, and Ontario. Leahey[1] makes a separation between the Eastern Podzols of the Maritimes and southern Quebec and those of the Canadian Shield. This is probably justifiable on climatic grounds as the eastern zone receives more rainfall and its soils are weathered more deeply and more completely than those of the northern region.

The climate of the Maritime Provinces varies from one of rather extreme continental conditions to one in which considerable marine modification is experienced.[2] Summer temperatures do not vary much, but there is great variation in winter. The January mean temperature is 5°F. in northern New Brunswick and 25°F. in southern Nova Scotia. Precipitation also varies from 35 to 55 inches per annum. Moisture deficiencies are small and droughts rather infrequent.

Canadian foresters recognize this region as possessing a distinct series of forest types. Halliday terms it the Acadian Forest Region. Of it, he says, "The Forest is related to the Great Lakes-St. Lawrence Forest, the

[1] Leahey, A.: op. cit.
[2] Putnam, D. F.: The Climate of the Maritime Provinces; Can. Geog. Jour., vol. 21, No. 3, pp. 134-147. Ottawa. September 1940.

dominant conifers of which, hemlock, white pine and red pine, are well distributed; to the Deciduous Forest, in possessing the so-called northern hardwoods, sugar maple, yellow birch and beech (which also occur within the former forest), and to the Boreal Forest through the presence of white spruce and balsam fir"[1].

An example of an eastern podzol of rather extreme development is the Woodville sandy loam, mapped in the Annapolis Valley and described by Harlow and Whiteside[2] as follows:

A (0 inch to 8 inches.) Greyish brown to light brown, sandy loam, loose, single grain structure; pH 4·8.
(8 to 14 inches.) Ashy grey, sandy loam, loose, powdery; pH 5·0.

B (14 to 24 inches.) Reddish yellow, sandy loam; loose and fairly mellow. Single grain to structureless; pH 4·9.
(24 to 50 inches.) Reddish brown or brownish red, sandy loam; quite firm but friable. Has a weak platy structure and contains fine quartz pebbles, giving it a gritty feel; pH 4·9.

C (Below 50 inches.) Grades into a redder loam to sandy clayey loam containing pebbles and fine gravel. Quite firm to compacted, crumbles readily when fractured and has a greyish cast; pH 4·9.

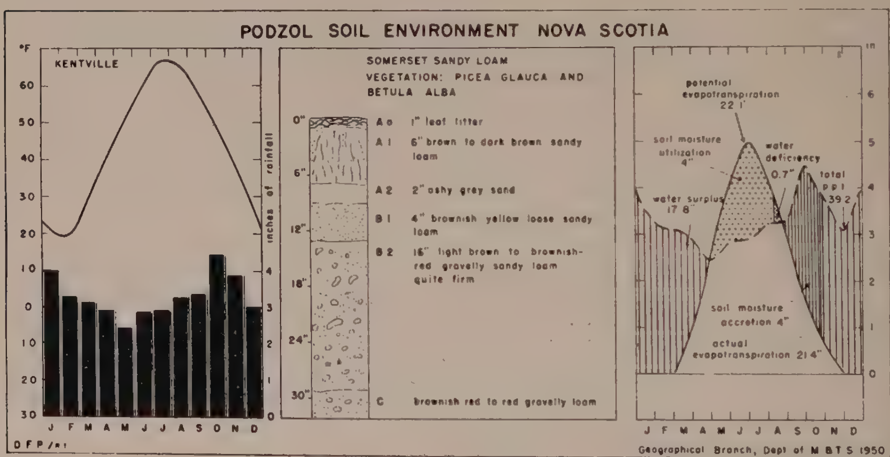

Figure 12. The environment of the Annapolis-Cornwallis Valley in Nova Scotia has a mixed forest vegetation in a climate that normally has almost a balance between moisture supply and water need in the warm season but a considerable excess in the cold season. Other parts of Nova Scotia have an excess at all times. Under such conditions the soils are highly leached.

The fundamental problem in leached acid soils like these is the maintenance of soil fertility, or rather the building up of soil fertility, as the virgin soil is almost too poor to grow crops. By judicious management, however, very satisfactory yields of many crops can be obtained. The soil described above, for instance, is one of the most desirable soils in the Annapolis Valley fruit-growing region.

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[1] Halliday, W. E. D.: A Forest Classification for Canada; Canada, Dept. of Mines and Resources, Forest Service Bull. 89, 50 pp. (Ottawa, 1937).

[2] Harlow, L. C., and Whiteside, G. B.: Soil Survey of the Annapolis Fruit-growing Area; Canada, Dept. of Agriculture, Pub. 752, Tech. Bull. 47, 92 pp. (Ottawa, 1943).

The environment of the eastern podzol zone is illustrated by Figures 12 and 13. The data in the former pertain to the Annapolis Valley section of Nova Scotia and the latter figure represents conditions in the western part of Newfoundland, a region in which it is suggested that there are possibilities for settlement.[1]

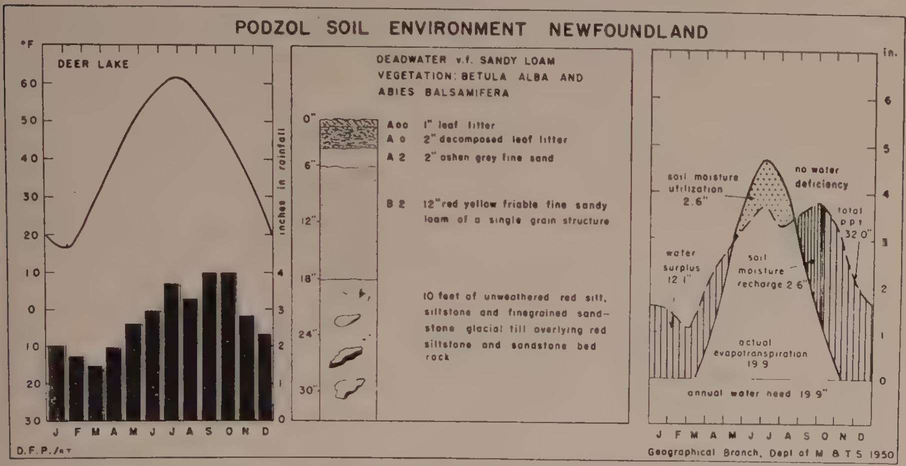

Figure 13. Deer Lake, in western Newfoundland, has podzol soils under a dominantly coniferous vegetation. High summer rainfall completely balances the climatic moisture requirement without exhausting the stored up moisture of the soil.

In Nova Scotia, New Brunswick, and, in particular, Newfoundland most of the land remains in forest, only a small percentage having been cleared and cultivated. This is undoubtedly more for geological and physiographic rather than pedological reasons as Prince Edward Island, with much the same sort of podzol soils, is one of the most completely occupied and cultivated parts of Canada. Both Prince Edward Island and New Brunswick are noted potato-growing areas. Climatically, of course, most of the eastern podzol zone is suited for potatoes, but only certain soil types seem to react satisfactorily to intensive cultivation and fertilization. Oats and hay are the main crops. Much of the land even though cleared is devoted to pasture, the moisture supply being more conducive to the growth of grass here than in other soil zones. Leahey[2] states that about 10,000,000 acres may eventually be used for agriculture.

The Northern Soil Zones

The northern podzol zone lies, for the most part, in the region that is underlain by Precambrian rocks. The depth of mantle rock is usually shallow and the profiles of the podzol soils developed in it are shallow also. Moreover, as the texture is coarse and the structure loose and permeable, water supply is usually insufficient for satisfactory crop growth.

[1] Wolfe, P. E.: Geology and Soils of the Upper Humber Valley, Newfoundland; Newfoundland, Dept. of Natural Resources, Soil Survey Bull. No. 3, 43 pp. (St. John's, Newfoundland, 1944).

[2] Leahey, A.: op. cit., p. 287.

This zone, however, contains some of the largest areas of potential farm land, not so much in its zonal soils but in the large areas of intrazonal soils that are associated. These are, almost entirely, flattish areas of clay or other water-laid sediments that have developed bog and half-bog soils, i.e., the Clay Belt of northern Ontario[1] and Quebec[2], the Lake St. John Lowland, and other smaller pockets in the Shield. Altogether, Leahey[3] estimates 15,000,000 to 17,000,000 acres of potential farm land, but it must be admitted that this is a conservative estimate. During the past 20 years more than 1,000,000 acres of Clay Belt land in northern Ontario have been manhandled only to be abandoned and the total improved land according to the census of 1941 was only 116,000 acres. On the other hand, in Quebec under closer supervision and government subsidies the effective colonization has been about twice as great.

The problems here, apart from climate, are poor drainage, the removal or proper incorporation of accumulated organic matter, and the creation of a proper physical condition in a clay soil that has undergone a great degree of gleization. At the present time the high cost of clearing and ameliorating these soils far outweighs the probable return from the narrow range of crops that may be grown. The great natural crop of the region is pulpwood, and possibly a combination forest settlement should be fostered in which only the best soils are cleared for crops and the rest devoted to managed forests.

The soils of the far northwest have as yet received comparatively little attention. Leahey[4] in 1947 reported on the soils of the Mackenzie Valley. He describes three soil zones. Most southerly of these is the grey wooded zone, which extends as far north as Fort Simpson (latitude 61° 52′ N.) where on an abandoned alluvial terrace under a mature stand of white poplar he found a soil development very like that of the Peace River district. There was no permafrost at this site.

At Fort Norman (64° 54′ N.) under a mixed forest of spruce, birch, alder, and willow on a level terrace the surface soil was slightly acid, but apart from some yellowish brown mottling showed little evidence of soil development. Permafrost was encountered at 39 inches (August 20, 1945). Fort Norman is considered to be in the Sub-Arctic zone.

Aklavik (68° 26′ N.) is in the Arctic zone. Permafrost was encountered at 20 inches. The surface had a pattern of polygons, 3 to 5 feet across, separated by narrow channels filled with organic soil. Under a shallow organic layer the top 4 inches of soil was slightly acid but the greyish brown sub-soil was practically unweathered.

Intrazonal peats and mucks are found in all three zones in great abundance. The azonal soils of the recent alluvium do not appear to differ from one zone to another.

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[1] Hills, G. A.: op. cit., p. 122.
[2] Rousseau, L. Z.: op. cit., p. 18.
[3] Leahey, A.: op. cit., p. 289.
[4] Leahey, A.: Characteristics of Soils Adjacent to the Mackenzie River in the Northwest Territories of Canada; Soil Science Soc. o 'Amer., Proc., vol. 12, pp. 458-461 (1947).

In another paper Leahey[1] discusses the Yukon territory in which about 500 acres are under crops. Here also, there is a marked division between the areas that have or have not permafrost. The Yukon Valley is a rain-shadow area with 5 to 7 inches of rain during the growing period. In the well-drained uplands, free from permafrost, the soils vary from dark brown types under grass to reddish brown forested soils with little evidence of podzolization. Soils in the permafrost area are usually poorly drained and have a thick covering of peat and muck.

Archibald[2] estimates that the Yukon has about 500,000 acres fit for agriculture, in addition to many hundreds of square miles of potential grazing land.

APPLICATION OF PEDOGEOGRAPHY

One important application of pedogeography is in connection with land classification, a subject in which geographers have long been interested. Many types of workers have taken part in such work and not a few systems of land classification have been devised by economists, land planners, geographers, and so forth. The attitude adopted by Canadian soil surveyors in recent years has been that, in so far as agricultural use is concerned, the primary classification should be a rating of soil capabilities as indicated by the natural characteristics of the soil itself. In accordance with this tendency the soil survey bulletins issued in a number of provinces contain land class maps, land use capability classes, or capability ratings. There is as yet no great uniformity in the practice of such ratings, but a sub-committee of the National Soil Survey committee is at work on it.[3]

The report on Carleton county, Ontario,[4] contains capability ratings in which five classes are established, into which the various soil units are placed with regard to their fitness to produce the leading crops of the region. The classes are defined as follows:

Class I.	Good crop land; well suited to the intensive production of general farm crops.
Class II.	Good to fair crop land. Moderately to well suited to intensive production of general farm crops.
Class III.	Fair crop land. Moderately suited to general farm crops. In some cases better suited to a combination of agriculture and grazing or forestry.
Class IV.	Fair to poor crop land. Moderately to poorly suited to general farm crops. Often better suited to grazing and forestry.
Class V.	Submarginal crop land. Very poorly suited for general farm crops. Generally better suited for grazing, forestry, or recreation. Some of the soils (e.g., muck) are suited to a specialized agriculture on selected areas.

On this basis 606,080 acres in Carleton county were classified as follows:

	Per cent		Per cent
Class I	19·1	Class II	20·4
Class III	11·5	Class IV	16·6
Class V	32·4		

[1] Leahey, A.: Factors Affecting the Extent of Arable Lands and the Nature of the Soils in the Yukon Territory; delivered at the Seventh Pacific Science Congress, New Zealand, February 1948.

[2] Archibald, E. S.: Agricultural Lands in the Canadian Northwest; Can. Geog. Jour., vol. 29, No. 1, pp. 40-51 (July 1944).

[3] Proceedings of the First Conference of the National Soil Survey Committee (1945): op. cit.

[4] Hills, G. A., *et al.*: op. cit., pp. 86-94.

The soil survey of the Wainwright and Vermilion areas in Alberta[1] makes use of the following soil rating: Group 1—poor to fair pasture; Group 2—fair to good pasture; Group 3—good to excellent pasture; Group 4—poor to fair arable land; Group 5—fair to fairly good arable land; Group 6—fairly good to good arable land; Group 7—good to very good arable land; Group 8—very good to excellent arable land. Arable land is appraised on its ability to grow wheat. Unfortunately, no breakdown of the relative areas of these groups is given.

The province of Saskatchewan also makes the capability to produce wheat the basis of its land classification or soil rating system. This yardstick has been applied to over 60,000,000 acres in the province, with the results shown in the following table:

Land Classification in Saskatchewan[2]

Class	Approximate acreage	Percentage
Best wheat lands	4,275,000	7·1
Very good wheat land	3,558,000	5·9
Moderately good wheat land	10,182,000	16·9
Fair wheat land	15,309,000	25·5
Total arable land	33,324,000	55·4
Unsuitable for cultivation	26,905,000	44·6
Total	60,229,000	100·0

In the pioneer areas of central British Columbia a very simple land classification is used[3]:

Arable land—fine-textured soils, subdued relief, mainly deciduous forest cover.

Temporarily non-arable land—potentially arable, but the density of forest cover makes the cost of clearing prohibitive at the present time.

Forest land—sandy, gravelly, or stony soils, muskeg, bluffs, ravines, hilly or mountainous land.

The area surveyed amounted to 690,869 acres of which 19·3 per cent was classed as arable and 22·3 per cent as temporarily non-arable. In other words the potentially arable land amounts to 41·6 per cent of the total land area.

These are isolated instances; others might have been chosen to illustrate the attempts at soil ratings made by Canadian soil surveyors. No overall comparison can be made as yet, however, of the various classes in different parts of the country.

[1] Wyatt, F. A., *et al.* (Appendix by J. A. Allen): Soil Survey of the Wainwright and Vermilion Sheets; Univ. of Alberta, College of Agriculture, Bull. 42, 122 pp., maps, illus. (Edmonton, September 1944).

[2] Saskatchewan, Dept. of Agriculture, Thirty-ninth Ann. Rept., Regina, 1944.

[3] Kelly, C. C., and Farstad, L.: op. cit., p. 54.

An extensive program of economic land use surveys has been carried out by the Economics Division, Marketing Service, Dominion Department of Agriculture, in western Canada in conjunction with the work of the Prairie Farm Rehabilitation Authority. Between 1935 and 1947, according to Mysak[1], over 28,000,000 acres had been classified and several reports have been issued since. The basis of classification as laid down in the first reports[2,3] is the ability of a quarter-section of land (160 acres) to produce wheat. This ability is related to soil characteristics, but in the final maps the natural land boundaries are obscured by adherence to man-made survey lines. These maps have proved of value in locating land of low economic status for the establishment of community pastures.

Similar work on an experimental scale has been done in Eastern Canada and a report covering two townships (138,800 acres) has been issued.[4]

Comparison of the economic land class map (Figure 7) of this report with the soil map of Durham county[5] brings out the close relationship between the economic land class and the soil type. Where a soil map is available the economic land classifier makes it the initial basis of his classification.[6] When soil types are grouped on the basis of their physical characteristics, as was done in this case, the result is very close to a land form map of the area and hence the economic divisions may be accurately evaluated by the physical geographer.[7]

Land classification in Ontario is also carried out by the Conservation Branch of the Ontario Department of Planning and Development. In this organization the pedogeographic work is under a trained geographer. The field staff includes foresters, wild life specialists, hydrographers, and geographers, who together give a very detailed account of the problems of an area. In the Ausable watershed[8], for instance, complete soil surveys were not available but the basic patterns obtained from the study of land form, surface material, soil profiles, drainage, and land use are knit into a geographic pattern from which precise recommendations for future land utilization programs may be made. The methods by which this result was achieved are very like those employed in the rural land classification of the Tennessee Valley Authority.[9]

In the integration of work already done, in the estimation of work to be undertaken, and in the actual execution of the work of land classification the geographic approach has many advantages.

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1 Mysak, S.: The Significance of Economic Land Use Surveys in Conservation Programmes; Scientific Agriculture, vol. 27, pp. 457-465 (1947).

2 Spence, C. C., and Hope, E. C.: Land Classification in South-central Saskatchewan; Canada, Dept. of Agriculture, Pub. No. 728, Ottawa, 1942.

3 Stewart, A., and Porter, W. D.: Land Use Classification in the Special Areas of Alberta; Canada, Dept. of Agriculture, Pub. No. 731, Ottawa, 1942.

4 Campbell, B. A., and Coke, J.: Land Use in Durham County, Ontario (Hope and Clarke townships); Canada, Dept. of Agriculture, Processed report, Ottawa, 1947, pp. 1-45.

5 Webber, L. R., *et al.*: op. cit., footnote 52.

6 Campbell, B. A., and Coke, J.: op. cit., p. 25.

7 Putnam, D. F.: Natural Regions of Eastern Ontario, *in* Conservation in eastern Ontario; Ontario Department of Planning and Development, Toronto, 1945, pp. 79-96.

8 Richardson, A. H.: The Ausable Valley Conservation Report; Ontario, Department of Planning and Development, Toronto, 1949.

9 National Resources Planning Board. Land classification in the United States. Washington, 1941. (*See* Chapter 18, "Land classification in the Tennessee Valley Authority".)

THE SOIL RESOURCES OF CANADA

For decades Canada was known as a land of agricultural expansion—of almost limitless growth—"The twentieth century belongs to Canada". During the present century according to this thesis the development of Canada would equal that of the United States during the nineteenth. No one ever actually set about to examine the premises of this theory while it was current and while Canada was actually expanding. When it became apparent to unwilling eyes that the growth rate was decreasing at the quarter century mark, various attempts at inventory were made.

Perhaps the most widely quoted estimates of potential farm land are those that appeared in the Canada Year Book for 1934-35 and in the report of the Census of Canada for 1931.[1] In it the estimate of possible farm land is given as 352,000,000 acres or 27·5 per cent or the total land area of the nine provinces. This estimate is just double the area that in the census of 1941 was reported as occupied land. It was, of course, made without most of the really scientific knowledge of the distribution of soil types in Canada, as the great bulk of this work has appeared in the last 15 years.

The latest, much more conservative, and much more scientifically accurate estimate of soil resources is given by Leahey[2] in the article already cited. In it he notes that although the occupied land is given as 174,000,000 acres, only 92,000,000 acres are listed as improved land and another 52,000,000 acres are in the category of prairie or natural pasture.[3] Moreover, although not tabulated by the census, several millions of acres of unoccupied land were also apparently being used as pasture. Leahey also believes that at least 5 per cent of the cultivated land is such that it should be permanently retired to grass or trees. The unused, potentially arable land in Canada is placed at 45,000,000 acres. Thus the total area of arable land, based, of course, upon the present standards and practices of Canadian agriculture, is about 130,000,000 acres.

Part of the 45,000,000 acres is already within the occupied area. Hurd[4], who recently made an exhaustive estimate, suggests that there are about 27,000,000 acres, or 60 per cent of this area, of "unused, reasonably accessible land which is regarded as physically suitable for agricultural settlement by experts in the provinces in which they are located".

Realizing that, except in certain favoured areas, Canadian land does not occur in continuous, uniform, easily divisible plains, it is apparent that in order to include the above 27,000,000 acres an equal amount of non-arable wild pasture or woodland will need to be occupied. We might, perhaps, expect to see 225,000,000 acres of occupied farm land, of which 130,000,000 acres would be arable and 85,000,000 acres be reported annually in crop. Under sufficient pressure this figure could, possibly, be raised to 100,000,000 acres.

[1] Dept. of Trade and Commerce, Dominion Bureau of Statistics, Seventh census of Canada (1931): Vol. 8—"Agriculture". Ottawa, 1936.

[2] Leahey, A.: op. cit.

[3] Canada, Dept. of Trade and Commerce, Dominion Bureau of Statistics, Eighth census of Canada (1941): Vol. 8—"Agriculture". Ottawa, 1947.

[4] Hurd, W. Burton: Post-war Agricultural Possibilities in Canada; Jour. of Farm Economics, vol. 27, pp. 388-404 (1945)

Other considerations besides those arising from the study of soils must enter into the estimation of potential agricultural production, and numerous estimates may be drawn up depending upon the systems of land use involved. Canada is naturally, in large measure, a forest land, and much of its potential will always involve the production of wood. It is, therefore, to be expected that settlement and land occupancy of the future will be planned on the theory of the multiple use of all resources. Agriculture and forestry may be combined in new areas and, even in areas long occupied by agriculture, a substantial part of the farm income may be derived from the woodlot. There is no logical reason why, in areas of differing soil resources, forestry might not be the main endeavour and agriculture the small but profitable sideline. The adoption of such a philosophy would provide a new basis for the calculation of production potential and population carrying capacity.

It is not the intention here to enter upon a discussion of the principles of land utilization. The purpose in hand has been merely to trace the development of pedogeography in Canada and to state the use of soil classification and mapping in the evaluation of natural resources. To date, these techniques have been applied almost exclusively to the study of agricultural potential. The day is at hand, however, when we shall think of our forests also as a planned crop and proceed with an inventory of all our soil resources. No resource is of any more vital importance than the soil; hence we must prepare for further rapid advances in the pedogeography of Canada and, indeed, of the whole world.

RÉSUMÉ

L'auteur appuie, au début, sur le besoin d'études "pédogéographiques" au Canada, à la lumière du rôle important joué par l'agriculture dans le développement du pays. Puis on retrace, dans un bref historique, l'opposition des premières administrations provinciales et fédérales à de telles sciences et études et, l'intérêt graduel pour les sciences pédologiques après la fondation de l'*Ontario Agricultural College* en 1874. Les relevés des sols dans les provinces sont compilés et cartographiés, montrant tout le territoire connu à l'heure actuelle, avec ses familles de sols, ses terres occupées, etc., et le territoire encore inconnu et non cartographié. Le territoire canadien est divisé en grandes zones ou domaines pédologiques fondés sur les travaux accomplis jusqu'ici. Ces zones sont décrites en tenant compte des facteurs suivants: associations végétales, climat, caractéristique du sol et utilisation présente. On compte dix grandes zones: 1° sols bruns, 2° sols brun foncé, 3° sols noirs, 4° sols gris boisé, 5° sols très calcaires, 6° sols de la Cordillère, 7° sols de la côte du Pacifique, 8° sols podzoliques bruns et gris, 9° sols podzoliques bruns, 10° podzols. Enfin, on résume les différents systèmes de classification des terres employés par les provinces, afin d'illustrer les techniques des agronomes et pédologistes canadiens, puis l'on cite les estimés de terres en fermes.

MAP NOTES

Selected Maps Published by Federal Mapping Agencies

Columbia River Basin. 1:12,000.

Canada, Department of Mines and Resources, Hydrographic and Map Service, Ottawa, 1946.

This set of maps, covering part of the Columbia River Basin within British Columbia, is being prepared in connection with the investigation of the water resources of the basin by the International Joint Commission under the Reference of March 9, 1944. In addition to hydrographic features, forest cover and land use are shown. The maps are closely contoured with intervals of 2 feet and 20 feet. There is a close network of spot heights and submarine elevations are also indicated.

It may be noted that four sheets of part of Okanagan River north of the International Boundary were published in a separate series in 1946 by the Joint Board on the Okanagan Flood Control.

Lines of Levels run in Western Canada to December 31, 1949. 1:2,534,000.

Canada, Department of Mines and Resources, Surveys and Mapping Bureau, Ottawa, 1949.

The map-sheet covers the provinces of Manitoba, Saskatchewan, Alberta, and southern and eastern British Columbia. Three categories of levels are indicated: precise, by heavy blue lines; secondary, by heavy red lines; tertiary, by thin red lines.

Lines of Magnetic Declination and Annual Change in Canada for 1948. 1:6,336,000.

Canada, Department of Mines and Resources, Surveys and Mapping Bureau, Ottawa, 1948.

The map-sheet covers Canada south of latitude 75 degrees and shows lines of equal magnetic declination (isogonic lines) for July 1948, and lines of equal annual change in the magnetic declination (isoponic lines). The information is based upon magnetic observations made at Dominion Observatory repeat stations throughout the country. The map fixes the position of the North Magnetic Pole a few miles inland from the east side of Ommanney Bay, Prince of Wales Island.

Lines of Equal Magnetic Declination and Annual Change in the Northwest Territories and Yukon for 1948. 1:5,068,800.

Canada, Department of Mines and Resources, Surveys and Mapping Bureau, Ottawa, 1948.

The map-sheet covers Northern Canada from approximately 60 degrees north latitude to the North Pole and includes parts of Greenland and Alaska. The magnetic lines were constructed by the Division of Terrestrial Magnetism, Dominion Observatory, from measurements made 1943 to 1948 inclusive.

Canada. 1:4,055,040.

Canada, Department of Mines and Resources, Surveys and Mapping Bureau, Ottawa, 1947.

A new issue of this political map of Canada was made in 1949. The only revision is the addition, in colour, of the province of Newfoundland.

World Aeronautical Chart, I.C.A.O. 1:1,000,000. Canada, Sheet 2263—Gatineau River.

Canada, Department of Mines and Resources, Surveys and Mapping Bureau, Ottawa, 1949.

This sheet is one of the series published by the Surveys and Mapping Bureau. Complete coverage of Canada is planned and will consist of sixty-five sheets. The base map is layered and contoured, the contour interval varying between 500 and 3,000 feet. Aeronautical information, marine lights, and isogonic lines are overprinted in magenta.

Canada. Aeromagnetic Series. 1:63,360. Sheet No. 31^{F}_{1}.

Canada, Department of Mines and Resources, Geological Survey of Canada, Ottawa, 1947.

The sheet is one of a series being produced by the Geological Survey with aeromagnetic information overprinted on the Topographic Map Series published by the Geographical Section, General Staff, Department of National Defence. The magnetic survey, August 1947, was by the Geophysics Section, Geological Survey of Canada, in collaboration with the Royal Canadian Air Force, and flights were made through the courtesy of the Flight Research Section, National Research Council. Magnetic information is overprinted in purple with magnetic contour intervals at 20, 100, and 500 gammas. Flight lines are shown in green.

Geological Map of the Maritime Provinces. 1:760,320.

Canada, Department of Mines and Resources, Geological Survey of Canada, Ottawa, 1949.

The map is designed to show on a comprehensive scale the available information on the geology of the three maritime provinces. It includes an index to recent geological maps on this area by the Geological Survey. Occurrences of metallic and non-metallic minerals are shown and glacial striæ indicated.

BOOK NOTES

Recent Government Publications of Geographical Interest

Plan for the National Capital, Canada, 1948. Preliminary Report. By Jacques Gréber. National Capital Planning Service, King's Printer, Ottawa, 1949.

This report was prepared on behalf of the National Capital Planning Committee. It outlines the purpose of the Canadian Government to develop the national capital and its environment and defines the Capital region, describes its geology and geography, outlines the history of its settlement and development, and concludes by an analysis of the present urban ecology. The report is illustrated with maps in black and white greatly reduced from large colour maps, and is accompanied by a complete list of maps, plans, and diagrams prepared for the National Capital Plan. [J.W.W.]

Native Trees of Canada. Canada, Dept. of Mines and Resources, Mines, Forests and Sci. Serv. Br., Dom. Forest Serv. King's Printer, Ottawa, 1949. 293 pp., maps, illus.

This fourth edition of Bulletin 61 has been completely modernized in style and format, new maps have been added, and photographic illustrations with a scale replace the former drawings. The extent of the natural occurrence of each tree species in Canada is indicated in the text and also on an accompanying range map in two colours, and a brief description of the economic uses of the different species is given. The body of the work, which is in two parts—coniferous trees and broad-leaved trees—is preceded by some notes on nomenclature, a list of botanical authorities, and a check-list of the native trees of Canada. [N.L.N.]

Types of Farming in Canada. By S. C. Hudson *et al.* Canada, Dept. of Agr. Pubn. 825, Farmer's Bull. 157. King's Printer, Ottawa, 1949. 83 pp., illus., tbls., map.

This is a co-operative study made by the Department of Agriculture and the Dominion Bureau of Statistics. The study portrays the farm situation as it existed in Canada according to the Census of 1941, and is divided into four parts: part one studies the relation of physical and economic factors to the geographical distribution of types of farming in Canada; part two describes the use of land resources in Canada for each principal agricultural product and livestock; part three deals with the geographical distribution of farm types; and part four stresses the types of farming according to regions (i.e., by provinces). [P.C.]

Aerological Data for Northern Canada. By T. J. G. Henry and G. R. Armstrong. Canada, Dept. of Transport, Meteor. Divn., Toronto, 1949. 271 pp., maps.

Aerological data are presented for each of the twelve stations north of latitude 58 degrees. "Normal" charts have been constructed for the 850-700, 500, and 300 millibar levels in January, April, July, and October. A map is included showing the location of the aerological stations and types of data recorded at each station. [B.J.M.]

An Increasing Atlantic Influence in Hudson Bay. By W. B. Bailey and H. B. Hachey. Joint Committee on Oceanography Publication. Atlantic Oceanography Group, St. Andrews, N.B., 1949. 11 pp., illus.

This report is based on oceanographic observations of temperatures and salinity made during the northern cruise of R.C.N. ships in September 1948. Eight stations were occupied in Hudson Strait and six in Hudson Bay. The results, if compared with those of the first detailed examination sponsored by the Hudson Bay Fisheries Expedition in 1930, show an increased Atlantic influence. All results are illustrated by graphs. [P.C.]

Soil Survey of Essex County. By N. R. Richards *et al.* Ontario Soil Sur. Rept. 11. Canada, Dept. of Agr., Expt. Farms Serv. and Ontario Agr. Coll., Guelph, 1949. 85 pp., tbls., illus., map.

The soil series have been classified on the basis of their development on similar parent materials. Within each series they are divided into soil types on the basis of texture. A further classification is noted according to differences of relief or drainage. The report lists altogether eight soil series. Present agricultural land use for each soil series is discussed, as is the chief fertility need for each type. Sketch maps, nineteen statistical tables, twenty soil profiles, and a soil map of the county (scale: 1 inch to 1 mile) provide adequate illustrations. [M.R.D.]

Background of the Great Lakes, St. Lawrence Waterway and Power Project. Canada, Dept. of External Affairs, Inform. Divn. Ref. pap. 40. Ottawa, 1949. 6 pp.

The first paragraphs of this reference paper describe the Deep Waterway Project of the St. Lawrence River, its potentialities for navigation, such as a continuous 27-foot navigation route throughout the entire Great Lakes-St. Lawrence system, and its potentialities for producing 2·2 millions additional horsepower. Then follows an historical sketch of negotiations between Canada and the U.S.A. about the project, from 1895 to the agreement of 1941. Explained in more detail are the agreement of 1941, the conditions of approval by the U.S.A., the effect of such conditions, and the work required under the same agreement. The most recent developments up to 1948 are also stressed, like the provincial contribution to the cost of the project, the cheap transportation route for the Quebec-Labrador iron-ore deposits, and the strategic importance for defence purposes. [P.C.]

GEOLOGICAL RECONNAISSANCE OF PERIBONCA RIVER from Passe Dangereuse to Onistagan Lake. By S. H. Ross. Quebec, Dept. of Mines, Geol. Sur. Br., Geol. rept. 39. King's Printer, Quebec, 1949. 20 pp., maps.

The writer describes the geology and topography of the Peribonca River Valley between Passe Dangereuse and Onistagan Lake. The work is based on a reconnaissance survey made by canoe in 1942 to investigate the rock outcrops along the valley before the area was flooded with waters impounded by the newly constructed storage dam at Passe Dangereuse. The report includes a detailed description of the surface features of the valley, an account of the geological formations and structure, and also observations concerning glacial phenomena. It is illustrated by four aerial and four ground photographs, by two strip reconnaissance maps and two geological maps of the Passe Dangereuse dam site. [B.V.G.]

AN INTRODUCTION TO THE GEOGRAPHY OF NEWFOUNDLAND. By B. V. Gutsell. Canada, Dept. of Mines and Resources, Mines, Forests and Sci. Serv. Br., Geog. Bur., Inform. Ser. 1. Ottawa, 1949. 85 pp., maps, illus., biblio.

This handbook presents an outline of the physical background and the economic development of Newfoundland, by dealing with its geology and physical features, climate and weather, natural resources, external trade, settlement, and communications in nine chapters. Labrador is dealt with separately in a four page chapter. There are three appendices: place-names of Newfoundland; maps and survey; bibliography. [N.L.N.]

THE DAIRY FARM BUSINESS IN MANITOBA, 1942 to 1947. By H. L. Patterson and H. W. Trevor. Canada, Dept. of Agr. Pubn. 829, Tech. Bull. 76. King's Printer, Ottawa, 1949. 41 pp., tbls., graph, map.

This study of dairy farms in Manitoba is principally economic, with sections on the farm business, and efficiency and costs in dairy enterprises. However, it relates the industry to available markets, climate, and soils, and briefly describes the land use. The relation of Manitoba production to that for Canada and to the world dairy situation is discussed, and variations in costs and returns and in farm methods and practices are related to economic factors, to location with respect to market and to soils and climate. [J.W.W.]

A FARM BUSINESS STUDY WITH PARTICULAR REFERENCE TO THE RELATION OF FARM TYPES AND LAND CLASS. Cory-Asquith-Langham area, Sask., 1943. By R. A. Stutt. Canada, Dept. of Agriculture, Ottawa, 1949. 72 pp., illus., tbls.

The author explains that a land classification based on "wheat-use capability" might not be sufficient, and he, therefore, introduces a comprehensive study of farm businesses and farm types. The paper is essentially an economic classification of land, and is divided into three main sections: Classification of Land Using an Economic Approach; Farm Organization; and Farm Business. The classification evaluates wheat yields and these are converted into terms of potential incomes, and on this basis five classifications are established. Ownership, tenure, occupancy, assessments, soil erosion, wheat yields, and farmhouse types are discussed and relations to the various land classes are drawn. Social and economic conditions are related to the type of land class. [W.A.B.]

Soil Moisture, Wind Erosion and Fertility of Some Canadian Prairie Soils. Soil Research Laboratory, Swift Current, Sask. Canada, Dept. of Agr. Pub. 819. Tech. Bull. 71. King's Printer, Ottawa, 1949. 78 pp., illus., chts., tbls., map.

This bulletin deals with problems of soil moisture, soil fertility, and soil erosion in the brown and dark brown soils of the Prairie Provinces, and particularly of southwest Saskatchewan. The period covered is 1943 to 1947. The subject matter outlines the results of experiments concerning soil moisture conservation, the effectiveness of fertilizers, wind erosion, and weed control. Various micro-studies deal with such matters as shelter-belts, soil temperature, the occurrence of selenium, the dynamics of wind erosion and its control, and the longevity and periodicity of germination of weeds. Various tables, graphs, and charts illustrate such things as the yield and moisture requirement of wheat, soil temperatures at depths of 1 foot and 4 feet, nitrate production, wind velocities at different heights, the intensity of soil drifting, and the properties of virgin and cultivated soils. A sketch map of the Prairie Provinces shows the location of Dominion Experimental Farms in the region, and gives precipitation and evaporation in the Farm areas.

[M.R.D.]

The Varietal Composition of Canadian Export Wheat, 1926-1946. By J. G. C. Fraser. Sci. Agr., vol. 29 (3). March 1949, pp. 97-127, graphs, tbls.

This paper develops in detail the trends in the varietal composition of Canadian export wheat. The introduction of new varieties of proven quality has tended to reduce the number of inferior varieties. According to the author, the undesirable varieties were not sufficiently great at any time to alter the general quality of Canadian export wheat, nor is there any basis for the criticism levelled in 1925, that wheat from Canada contained an "undesirable mixture of varieties". [W.A.B.]

Transactions of the Second Resources Conference, Victoria, B.C., February 17-18, 1949. British Columbia, Department of Lands and Forests, 1949. X-330 pp., maps, tbls., chts., mimeo.

The second British Columbia Natural Resources Conference had as its theme "The Wealth of British Columbia—a study of the province's natural resources, their status and inter-relations". The transactions, therefore, consist essentially of a series of papers presented by authorities in their respective fields of soil, water, agriculture, fisheries, forestry, mining, power and energy, recreation, and wildlife. In most cases an attempt is made to interpret the resource in terms of people. Each paper is followed by a discussion. This publication includes many statistical tables and diagrams as well as the following maps in colour: (1) Tentative Soil Zones (scale: 55 miles to the inch); (2) Generalized Geology and Mineral production (scale: 60 miles to the inch); (3) Developed and Potential Power Sources (no scale stated); (4) The present Provincial Parks of British Columbia (scale: 55 miles to the inch). Although this inventory must be regarded as tentative, as the exploration of resources in British Columbia is far from complete, it is a most authoritative and up-to-date work. [N.L.N.]

Lands, Surveys and Water Rights Branches, Annual Report, 1948. British Columbia, Dept. of Lands and Forests. Victoria, 1949. 188 pp., maps, tbls., illus.

This publication includes the following reports: (a) of the Lands Branch including Land Utilization Surveys and Land Inspection; (b) of the Surveys Branch detailing the greatly increased work by the Air, Topographic, and Geographic Divisions, the latter reporting progress on a new gazetteer of British Columbia, and a report on the British Columbia-Yukon boundary survey; (c) of the Water Rights Branch including surveys on snow, water resources, and power; (d) coal, petroleum, and natural gas control reporting the recent progress in petroleum investigation; (e) on dyking and drainage; (f) on the southern Okanagan lands; (g) University Endowment Lands. The maps include: (1) air photographic coverage as of Dec. 31, 1948; (2) an index of topographic surveys as of Dec. 31, 1948; (3) the location of developed and potential power sites; (4) the B.C.-Yukon boundary survey 1945-1948; (5) the Bulkley River Power Section. [B.J.M.]

THE PHYSIOGRAPHY OF THE AGRICULTURAL AREAS OF BRITISH COLUMBIA. By V. C. Brink and L. Farstad. Sci. Agr., vol. 29 (6). June 1949. pp. 243-301, maps.

The complexity of surface forms in the past appears to have discouraged attempts at appraising the nature and extent of agricultural lands. In view of this the authors believe such an appraisal of agricultural land potentials can best be made by adopting a physiographic approach. To present a simplified picture they recognize a few physiographic divisions: Western Mountainous Belt; Central Belt of Interior Plateaux; Eastern Mountainous Belts; and the Tramontane Plains. With the exception of the last division, these are in turn subdivided into two or three provinces. The physical characteristics of each physiographic province are described, smaller subdivisions having agricultural possibilities are treated in detail, and such qualities as surface form, soils, drainage, vegetation, elevation, and the extent of present utilization are outlined. Eight maps designate the probable location and distribution of the arable areas within the province. Frequent reference throughout the study is made to a comprehensive bibliography of approximately eighty items that are listed at the end of the paper. [W.A.B.]

SOIL SURVEY OF THE OKANAGAN AND SIMILKAMEEN VALLEYS IN BRITISH COLUMBIA. By C. C. Kelly and R. H. Spilsbury. B.C. Dept. of Agr. in Co-operation with Dom. Dept. of Agr., Expt. Farms Serv., rept. 3 of B.C. Sur. King's Printer, Ottawa, 1949. Maps.

This report locates, describes, and classifies, exclusive of the lakes and rough mountain lands, some five soil types comprising twenty soil series of over 345,000 acres in the Okanagan and lower Similkameen valleys. A general introduction describes such features as location and extent, topography, drainage, surface geology, climate, history, and agriculture. Soils are described as products of such environmental conditions as parent materials plus topographic, climatic, and biological factors, and are classified according to the soil profile. The term "series" designates a group of soils on uniform parent material with the same colour, depth, and structure of horizon, and similar conditions of drainage and topography; within the soil series are soil classes based on texture of the surface soil or "A" horizon. Seven statistical tables, two sketch maps, and a soil map organize and locate the data contained in the text. [M.R.D.]

THE FROST-FREE SEASON IN BRITISH COLUMBIA. By A. J. Connor *et al.* Canada, Dept. of Transport, Meteor. Divn., Toronto, 1949. 20 pp., map, processed.

The first 15 pages of this booklet consist of 25 explanatory notes that relate site factors and meteorological situations to the data appearing in tables in the last 5 pages. These tables show the average, earliest, and latest dates of the last frost in spring and the first frost in autumn, and use the convention that a frost occurring before July 15 is a spring frost and a frost occurring after July 15 is a fall frost; the average frost-free period (days); the number of years of observation; and the height above M.S.L. for 258 stations in British Columbia. The stations are located on a map, in colour, on a scale of 55 miles to the inch. [N.L.N.]